Creating an iDTV Application from Inside a TV Company: A Situated and Participatory Approach

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Abstract. TV is a highly social and massive media that is worldwide available. The Interactive Digital TV represents a new device that is still constructing its identity. Designing applications for it is a challenging task, partially because of its intrinsic complex context and the lack of theoretical and methodological referential to support design activities. In this paper, we argue for a Socially Aware Computing approach to the design of iDTV applications, articulating artifacts and methods from Organizational Semiotics and Participatory Design. A case study on requirements for the design of an iDTV application is situated in the practical context of a Brazilian broadcasting TV Company. The results show benefits of using informed artifacts and methods in participatory and situated practices, indicating that it is possible and viable to make socially aware design in industrial settings.

Keywords: Socially Aware Computing, Organizational Semiotics, Participatory Design, Interactive Digital TV, Human-Computer Interaction.

1 Introduction

TV is recognized as a highly social technology. TV sets are displayed in living rooms, offices, restaurants and other private and public spaces. Outside their homes, people talk about football, novel/series episode, and even recommend interesting TV shows. More than high quality video and audio – including digital transmission, receiver processing capability and interactivity channel – the Interactive Digital TV (iDTV) is a medium that makes it possible the dissemination of interactive applications. With advances in Web 2.0 and Information and Communication Technologies, the iDTV is embedded and linked to other media that opens up a variety of possibilities for TV, such as its use in conjunction with mobile devices to complement the TV content, or even as a gateway to information via the Internet [6].

Considering the complex social context in which people live and the TV is inserted, Buchdid and Baranauskas [4] highlight the need for studies that consider the TV within a digital and social ecosystem, recognizing and addressing technical and social issues in order to design solutions that make sense to people. In the same way, Cesar et al. [6] highlight that research on social iDTV, which incorporates features of viewers and contextual information, has been scarce. In fact, several research works have suggested the importance of comprehensive and contextual studies to propose devic-

es, services and applications that make sense for the diversified population reached by iDTV (e.g.; [5], [6], [15]).

For TV broadcaster companies, while there is a demand for producing interactive content, the development of an application is a new element for their supply chain. Developing applications for iDTV is different from developing traditional software systems (e.g., Web); thus it can hardly be supported by an existing software development methodology [19]. Furthermore, as it is common for an emerging technology, the iDTV suffers with lack of references (e.g., sample applications, processes, mechanisms for evaluation, good practices guides) to assist any development processes [8].

In this sense, there is a demand for a design process suitable to the needs of the complex and dynamic context of a TV Company, while meets the needs of diverse audience reached by TV. Therefore, this study investigates the possibility of conducting design practices inside the context of an organization in order to understand the organizational culture and deal with the different forces that exist in its complex context. For this, in this paper, we draw on the Socially Aware Computing [2] to clarify requirements for an iDTV application, with Participatory Practices supported by Organizational Semiotics artefacts in situated contexts. A case study in the context of EPTV [7], a Brazilian broadcasting company, presents the design of an application for the "Terra da Gente" (TdG) ("Our Land", in English) TV show [18], and shows the results of our practices in an industrial setting.

The paper is organized as follows: Section 2 introduces the background of our work; Section 3 presents the case study in which the practices were conducted and Section 4 presents and discusses the main findings from the case study analysis. Finally, Section 5 presents our final considerations and directions for future research.

2 Theoretical and Methodological Foundation

The Socially Aware Computing (SAC) [2] is an approach to the design of information systems that extends and articulates ideas from Organizational Semiotics (SO) [9, 17] and Participatory Design (PD) [12] to make design socially responsible, participatory and universal as a process and a product. The SAC supports the understanding of the organization, the solution to be designed, and the context in which the solution will be inserted, so that it can potentially meet the sociotechnical needs of a particular group or organization.

The SAC has been used to support design in scenarios of high diversity of users (regarding skills, age, gender, special needs, literacy, intentions) [13]. Specifically for the iDTV context, SAC has been used to support the consideration of stakeholders' values and culture during the design process [14], for proposing recommendations to iDTV applications [15] as well for designing physical interaction devices for TV [11].

The SAC draws on the Semiotic Onion [17] to represent the idea that a design process needs to be conducted through its three nested levels: informal, formal and technical. The informal level refers to social norms that regulate behavior, beliefs, values, habits, culture, etc., that drive people's behavior. The formal level involves rules and procedures are created to explain mechanistic and repetitive tasks. The technical system is only part of the formal level of an organization, which can be automated.

Therefore, a design process should be understood as a wave that begins from outside to inside the Semiotic Onion, crossing the informal and formal layers to result in a technical system – see "SAC" detail in Fig. 1. This wave brings to the technical system relevant aspects of the informal and formal layers. Therefore, returning back to the social world, the technical system will impact on formal and informal layers alike, including the target-users, the environment in which it is/will be inserted, potentially promoting acceptance/adoption [2].

In SAC, design activities are conducted in Semio-participatory Workshops (SpW) [3] with individuals in their different roles (e.g., designer, developer, user, other stakeholders) – the ones who may direct or indirectly influence or be influenced by the problem being discussed and the solution to be designed. The idea is to bring up the viewpoint of different stakeholders situated in different layers of the organization to understand its situational context and the system inside it.

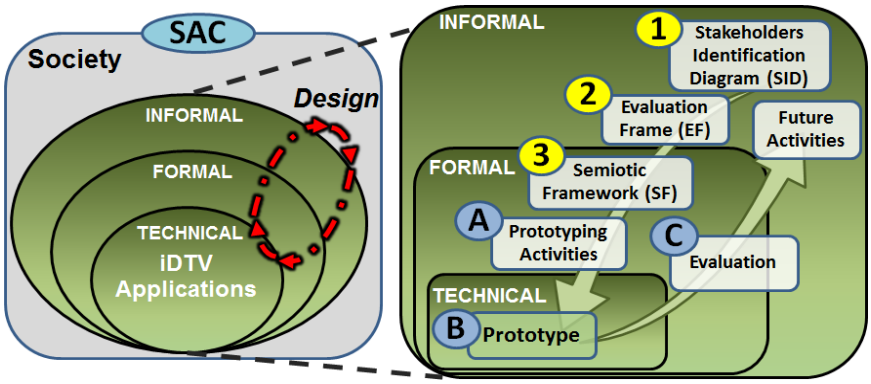

Fig. 1. Proposed design process from SAC's meta-model for design.

Inspired by Baranauskas' SAC approach [2], we draw on artifacts from OS and design practices from PD in order to propose practices for supporting design activities in a situated context. Fig. 1 presents details indicating three semiotics artifacts chosen for supporting the problem clarification and solution proposal in a participatory and situated context: (1) Stakeholders Identification Diagram (SID); (2) Evaluation Frame (EF); and (3) Semiotic Framework (SF).

The SID [10] is an artifact from OS that facilitates the identification of the parties involved in a particular design situation; going beyond obvious classes of stakeholders (e.g., user, client, manager), it pays attention to different levels of involvement, interests, and expectation. The EF, proposed by Baranauskas [1], extends the SID to support reasoning about problems and solutions related to each stakeholder; it favors the clarification and identification of requirements as well as the anticipation of issues that may impact/influence the solution to be designed. Finally, the SF [16] is an artifact from OS that, in the context of our work, favors the identification and organization of requirements according to six different communication levels. The first three levels are related to technological issues (the physical, empirics, and syntactics), and the other three levels are related to aspects of human information functions (semantics, pragmatics and social world) [9].

The artifacts articulate information from each other, not linearly: e.g., if during the practice with the SF or the EF a new stakeholder is identified, the SID must be updat-

ed, eventually resulting in an update of SF and/or EF. The information produced through the artifacts and the practices support further design activities, such as drawing, constructing and evaluating a prototype for the solution (see details "A", "B" and "C" in Fig. 1). Therefore, the SID, EF and SF are articulated in participatory practices with key stakeholders: while the SID and EF lead participants to think about aspects related to the stakeholders, their needs, expectations, problems, challenges and ideas, the SF supports the organization and specification of these aspects as requirements for design decisions regarding the prospective application.

3 Case Study: the Situated Context and Methodological Approach

The TdG TV show is one of several programs produced by EPTV whose programming reaches more than 10 million citizens living in a micro-region of about 300 cities, in São Paulo and Minas Gerais States, Brazil [7]. TdG explores local diversity in flora and fauna, cooking, traditional music, and sport fishing; it runs once a week and counts on a team of editors, writers, producers, designers, technicians, engineers and journalists, among other staff members. Besides the TV show, the TdG team also produces a printed magazine and maintains a web portal related to the subject [18].

This section presents the main activities conducted to clarify the problem domain and to identify potential requirements for the first prototype of an iDTV application for the TdG program, named iTG. This would be the first interactive application in the TV Company. In these activities, participants used the SID, EF and SF artifacts in 2 participatory and situated workshops for understanding the problem context, clarifying, analyzing and organizing requirements for the application to be designed. The activities were conducted from January to July, 2013, and involved 8 participants playing different roles at EPTV*: TdG Chief Editor:* coordinates the production team (e.g., editors) of the TV show and the web portal. *Designer***:** is responsible for the graphic art of the TV show, web portal, and iDTV application. *Operational and Technological Development Manager:* coordinates the department of new technologies. *Supervisor of Development and Projects:* coordinates the staff in the identification and implementation of new technologies. *Engineer on Technological and Operational Development:* works on infrastructure, and content production and distribution. *Technician on Technological and Operational Development:* is responsible for the implementation, support and maintenance of production department. *Intern:* an engineering student who is in training at EPTV. Three researchers in Human-Computer Interaction were responsible for preparing and conducting the workshops: two are experts in the SAC approach and the third is an expert in iDTV technologies.

The activities started with the identification of the interested parties. As an **input**, a poster with the SID was previously filled in with post its containing stakeholders related to iDTV applications coming from literature [5] and adapted to the TdG scenario. The participants were invited to propose new stakeholders, remove irrelevant ones, and exchange the position of stakeholders inside the diagram. Every change should be discussed among the group members (see "A" detail in Fig. 2). The **output** was a diagram that reflects the stakeholders involved in the problem domain according to

the participants point of view. This activity was key for identifying the main forces as well as constraints that the team would face during the project.

Fig. 2. Participatory activities in a situated context.

Having identified the stakeholders, the participants were invited to fill in the **EF** artifact in order to think about possible important issues related to the different stakeholders, and the way they could affect the project ("B" detail in Fig. 2). As **input**, the participants used the SID previously filled in, and their practical knowledge about the domain. The **output** was a collaboratively filled frame that presents requirements and constraints, observations and ideas, problems and suggestions related to different stakeholders' issues. This practice was important to identify the forces (interests) among the participants in the situated context, generating discussion and ideas for the iDTV application to be designed.

Finally, a workshop with the **SF** was conducted to organize the material produced from the previous practices in order to make explicit the requirements for the prospective iDTV application. As **input** for the activity, the SF was filled in with post its containing requirements identified through the EF, and with requirements for iDTV applications coming from literature [5]. Therefore, participants were asked to discuss and validate the diagram previously filled in, keeping, removing, and proposing new requirements for the application to be designed. All the decisions came from the group discussion ("C" detail in Fig. 2). The **output** of this activity was an organized list of requirements for the application to be designed.

Before each activity, the results obtained from the previous activities were presented and discussed in a summarized way, and the techniques to be used, as well as their methodologies and purposes were introduced to the participants. Posters with printed artifacts, pens and post its were prepared and provided to participants in each activity. During all the practices, the participants worked in a single group. Table 1 presents, for each activity presented in this paper, the time spent by researchers for introducing the artifacts and explaining how the participatory practices should be performed ("Introduction Time" column), the time spent by participants to perform each activity ("Practice Time" column), and the total time spent in each practice ("Total" column).

Table 1. Time spent for conducting the activities presented in this paper.

Practices	Introduction Time	Practice Time	Total
Stakeholders Identification Diagram (SID)	15 min	30 min	**45 min**
Evaluation Frame (EF)	10 min	35 min	**45 min**
Semiotic Framework (SF)	15 min	50 min	**65 min**
Total	**40 min**	**1h 55 min**	**2h 35 min**

The results from these activities (e.g., artefacts filled in) were used to generate design ideas for the first iTG prototype. These ideas were materialized through an adapted version of the Brain Draw participatory technique ("A" detail in Fig. 1) guid-

ed by Design Patterns for iDTV [8], supporting the construction of interfaces as well as an interactive prototype for the application. The final prototype was evaluated both interactively in a participatory practice and with representatives of end users ("C" detail in Fig. 1); the materials and results produced in these activities were used to inform requirements for the design of the iTG application.

4 Results and Discussion

The SID resulting from the participatory practices at EPTV (Fig.3) shows that there are many stakeholders potentially involved in the iTG application. The interested parties directly connected with the Broadcaster Company and iTG application are in *italics*, while the audience, which will be directly affected by the iTG application is underlined. The other stakeholders were brought from the literature [5] and were validated by the participants in the workshop.

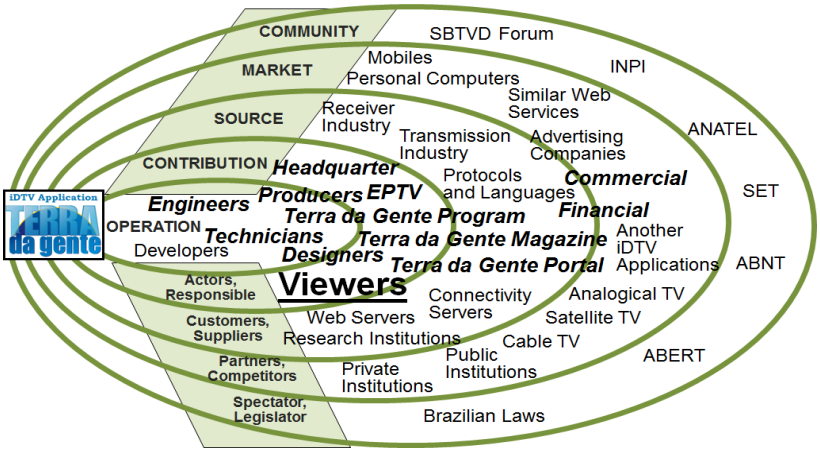

Fig. 3. SID resulted from the participatory practice.

For example, in the operation layer there are Engineers and Technicians. Between the operation and contribution layers are the Producers and Designers. The EPTV as well as the TdG program are in the contribution layer because they are directly responsible for the development of the iDTV application. The "Terra da Gente" printed Magazine and Web Portal are crossing layers because they may advertise the iDTV application. The Commercial and Financial departments are between the source and market layer because they can define the economic viability of iDTV applications. Most stakeholders removed during the workshop were in the community layer. Some stakeholders were removed because participants understood that these stakeholders were already incorporated into the ABNT (acronym for Brazilian Association of Technical Norms) standard, or entities such as ANATEL (National Telecommunications Agency) and other regulators. The headquarter, which was initially proposed in the community layer, was moved to the contribution layer due to the great influence of its premises and rules on the iDTV applications. Software companies were also removed since they intended to hire developers as staff of the EPTV to do the job.

Other stakeholders were validated by participants due to their importance in the context of the application being developed (e.g., mobiles and personal computers can directly compete with iDTV applications).

Table 2 shows the EF resulted from the practice. It indicates that most issues were found in the contribution layer. The main problem emphasized during the activity was the "*Competition of the iDTV application with the TV content*": the main concern of the participants is that the interactive application should not disrupt the viewers from the main content of the TV show. The solution proposal for this issue was to "*Develop an application with the lower possible impact on the TV content*". The market layer was not worked out by the participants because the application would not have advertisements competing with the TV show sponsors.

Table 2. EF resulted from the participatory practice.

Stakeholders	Problems and Issues	Ideas and Solutions
Operation	1. Labor (Human resources). 2. Application maintenance.	1. Hire professionals. 2. Simplify operations.
Contribution	1. Headquarter approval. 2. How to attract the viewer? 3. Competition of iDTV application with the TV content. 4. Policies of call the iDTV application. 5. Return channel constraints. 6. Graphic patterns.	1. Respect pre-established premises. 2. Advertise in the TdG website and magazine. 3. Develop an application with the lower possible impact on the TV content. 4. Broadcast the application in a transparent way for the user. 5. Identify the existence of return channel before trying to use it. 6. Experience different design elements.
Source	1. Existence and adequacy of receivers in accordance with standards.	1. Develop applications according to the standard, regardless of the receiver brand and model.
Market	--------	--------
Community	1. How to identify iTG acceptance?	1. Use the web portal to support measurement.

Table 3 presents the requirements proposed for the iTG application, organized according to the SF artifact. The requirements in *italics* were identified during practice with the EF, while the underlined requirements were identified during the practice with the SF artifact. The other requirements were brought from literature [5] and were adapted to the TdG context. All requirements were validated by the participants.

Table 3. SF instanced from the participatory practice**.**

Level	Requirements
Social World	***1. Provide the least possible impact on TV content;*** 2. Consider the diversity of the target audience; 3. The remote control should be the main interaction device (due to costs).
Pragmatics	***1. Integration with other communication channels (content, website and magazine);*** **2. Application with short interaction paths (few steps to reach the goal); 3. The application must challenge and encourage users to interact (motivation should be associated with the application content);** 4. The application should be easy to understand and use.
Semantics	***1. Respect headquarter premises; 2. Identify when it is possible to use the return channel and adapt the application for it; 3. Use the TdG portal to prospect the application acceptance;*** 4. Ensure accessibility, usability and universal design; 5. clearly show the application features and relate them to the remote control's buttons.
Syntactics	***1. It should be easy to maintain; 2. Respect graphic patterns (characteristic of the TV);*** **3. Must be asynchronous to the TV content;** 4. Indicate to users when the application and updates are available (conditional); **5. Observe the constraints of the programming language used.**
Empirics	1. Develop mechanisms to reduce the low speed transmission; 2. Consider the quality of the connectivity service available; 3. Use a web server suitable to a large number of connections.
Physical World	***1. Follow the ABNT standard;*** 2. Consider the receiver limitations (memory and processing); 3. Consider different kinds of receiver brands and models.

Some initially proposed requirements were excluded from the artifact by the participants. For example: i) "*the need to transmit the application for mobile devices*" was removed because the participants decided that the iDTV application should transmit just to TV devices; and ii) "*alert users when using the return channel*" (associated with costs of using it) was removed because there will be no additional costs for those who already have internet connection.

As results of these practices, participants stated that the iTG application should be informational, so that users could have extra information that do not fit in the TV show content, not disturbing the audience´s attention to the program content. The application should reach the same audience of the TV show: people from all ages, mainly adults and elderly people that enjoy fauna and flora, fishing, ecotourism and regional cuisine.

The results from the practices supported the construction and evaluation of an interactive prototype for iTG (Fig. 4). For example: "A" detail shows the simple layout that covers only the screen edges, following the headquarter premises to "*provide least possible impact on TV content*"; the "B" detail shows a menu with few options and few hierarchical levels, which is directly linked to the requirements: "*the application should be easy to understand and use*" and "*application with short interaction path (with a few steps to reach the goal)*". The "C" detail represents treatment for the requirements: "*clearly show the application features and relate them to the remote control's buttons*" and "*the remote control should be the main interaction device (due to costs)*". Finally, "D" detail shows a game to motivate the viewers to interact with the program content; this feature represents the requirement: "*the application must challenge and encourage users to interact (motivation should be associated with the application content)*".

Fig. 4. First Prototype for the iTG application.

The situated and participatory practices supported by the informed artifacts were essential to provide an understanding about the problem domain, the solution to be designed and the different forces and interests that should be taken into account. The practices led to the construction of a collective knowledge about the problems that we would face during the process of designing an iDTV application, revealing interests of the participants, favoring discussions and the comparison of different viewpoints,

levels of abstraction (informal, formal and technical), and so on. For example, envisaged Poll and/or Quiz features generated discussions among participants throughout the design process. From a technical viewpoint, the return channel required for these features is only possible if the TV is connected to the Internet, which does not occur with most Brazilian TVs (see "Contribution" layer in Table 2). From a practical perspective, a Poll could captivate viewers, becoming a direct communication channel between them and the TV show. However, according to some influential stakeholders, it could disperse the viewers' attention. After discussion, the participants agreed to use the return channel and its services, specifying the following requirement: "*Identify when it is possible to use the return channel and adapt the application for it*".

The practices allowed participants to see the problem from different perspectives, generating ideas for the application; e.g., the participants became aware that, besides maintenance issues that may spend human and financial resources, the application must be primarily concerned with the end user, respecting accessibility and usability issues, as well as normative questions, such as the headquarter premises and the TV show content. Moreover, issues that go toward the informal layer gained notoriety during the process: when faced with the amount of stakeholders in SID, one participant said: "*We had never thought of that range of stakeholders; only about the ones closer to the problem and those related to technical issues"*. Concerns, such as "*How to evaluate the application acceptance?*" and "*Consider the diversity of the target audience*" also represent issues that would hardly be thought without the artifacts and practices conducted.

The SID allowed us to observe that only those who are immersed in the situated context can measure the importance of some stakeholders: e.g., several stakeholders at the community layer were grouped into stakeholders that really made sense to the participants. The same was perceived with the EF and SF, in which some requirements would not be easily identified whether no participatory practice was conducted in a situated scenario. For example, the requirement: "*It should be easy to maintain*" is directly linked to the problem "*Labor (Human resources department)*" and the lack of developers in the broadcasting company.

Filling in the SID and EF beforehand was important to give participants a starting point as well as to reduce the workshop time. The initial stakeholders and requirements promoted discussion between the participants, leading them beyond their initial viewpoint/opinion. For example, ethical issues associated to the use of the return channel were remembered and discussed during the activities. These issues are of utmost importance in technologies for human use, even more in applications that reach a wide audience, not only because of the user, but also because of the reputation of both the broadcasting company and the TV show.

Using SO artifacts and conducting participatory design in the company settings was not considered expensive, as it could be supposed to be: only two workshops, lasting less than 2 hours each, were sufficient to the phase of clarifying the problem reported in this case study. Considering the whole design process, from the problem clarification to the prototype evaluation, less than 12 hours were required from the group. These results suggest that the Social Aware Computing in a situated context is a possible and viable approach to the design of iDTV applications.

Finally, as lessons learned from our practices, we point out the importance of having a person from the organization that acts as a mediator between the organization's

members and external participants (e.g., researchers). This person must understand the differences in language and culture, as well as the interests of different participants and stakeholders in the activities to be conducted in order to deal with different tradeoffs. Also, during the practices it was possible to perceive among the insiders the existence of two groups with competitive views: those who were betting on interactivity as a mechanism to attract the audience, and those who were not, arguing that interactivity could disturb the viewers from the TV Show content. In this case, the researchers, supported by OS artifacts, acted as the mediators in the negotiation for reaching final decisions.

5 Conclusion

The design of iDTV applications presupposes a comprehensive and contextual analysis for the application to make sense for the diversity of possible audience. In a broadcasting company, the design of iDTV application is a new activity that is not yet in its supply chain. In this sense, practices that understand the company's needs, that is suitable to their production chain, and that favor the design of applications that make sense to viewers are welcome. In this paper, we presented three participatory practices with artifacts adapted from the Organizational Semiotics to understand a situated context at different levels of abstraction and from different viewpoints in order to clarify requirements for an iDTV application.

The practices were important to generate discussions among participants, promoting the understanding of the main interests and conflicts inside the company's context, the constraints and possibilities of the application being designed, the role of the application within the TV show, what it should provide to the viewers, and so on. Understanding the situated context was also important to the proposition of participatory practices suitable to the broadcasting company reality, allowing the participants to effectively clarify the problem and propose design solutions for an iDTV application in a collaborative way. The findings suggest that the practices are viable to be conducted in practical contexts, requiring reasonable time and few resources of the broadcasting company.

Other OS methods and artefacts may still be used for further studies. For example: the semantic analysis and the norm analysis could be previously elaborated and worked in a participatory workshop as well. The application designed from the activities presented in this paper is being implemented and tested to be broadcasted with the TV show.

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