Playing Cards and Drawing with Patterns
Situated and Participatory Practices for Designing iDTV Applications

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Abstract: Making design has become a challenging activity, in part due to the increasingly complexity of the context in which designed solutions will be inserted. Designing iDTV applications is specially demanding because of the scarce theoretical and practical references, problems that are inherent to the technology, and its social and pervasive aspects. In this paper, we investigate the design for iDTV by proposing three participatory practices for supporting a situated design and evaluation of iDTV applications. A case study reports the use of the practices in the real context of a Brazilian broadcasting company, aiming at developing an overlaid iDTV application for one of its TV shows. The practices were articulated in a situated design process that favored the participation of important stakeholders, supporting different design activities: from the problem clarification and organization of requirements to the creation and evaluation of an interactive prototype. The results suggest the practices' usefulness for supporting design activities, indicate the benefits of a situated and participatory design for iDTV applications, and may inspire researchers and designers in other contexts.

1 INTRODUCTION

In the last years, the amount and diversity of technical devices have increased both inside and outside people's homes (e.g., tools, mobiles, cars, airports), being increasingly interconnected (e.g., through bluetooth, wireless LAN, 4G) (Fallman, 2011). Systems are not working in isolation, but in plural environments, bringing different people together as citizens and members of global communities (Sellen et al., 2009). As Bannon (2011) suggests, in this scenario, there are problems that go beyond the relationship between users and technologies, requiring more than a man-machine approach and ergonomic fixes to make useful and meaningful design.

Therefore, designing interactive systems is becoming a more complex task, not only in the technical sense, but also in the social one (Fallman, 2011). However, Winograd (1997) highlights that the majority of techniques, concepts, methods and skills to make design for a new and complex scenario are foreign of the computer science mainstream. In this sense, it is necessary to look at the technology comprehensively within the situated context in which it is embedded, incorporating knowledge of several stakeholders, areas, subjects and theories (Harrison et al., 2007).

Within this scenario, the emergency of the Interactive Digital TV (iDTV) (which includes digital transmission, receiver processing capability and interactivity channel) opens up a variety of possibilities for new services for TV (Rice and Alm, 2008). However, as Bernhaupt et al. (2010) argue, with new devices connected to TV, watching it has become an increasingly complicated activity.

In fact, the iDTV has technical issues as well as social characteristics that influence directly their use and acceptance. For instance: the interaction limited by the remote control, the lack of custom of people to interact with television content, the high amount and diversity of users, the usual presence of other viewers in the same physical space, to cite a few (Kunert, 2009). As Cesar et al. (2008) assert, the TV is a highly social and pervasive technology — characteristics that make it a challenging and interesting field to investigate, but that usually are not receiving attention from current works.

Despite not abundant, some literature has proposed ways to support the design of iDTV applications. Chorianopoulos (2006) analyzed works on media and studies about television and everyday

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life, proposing design principles to support user interactivity during leisure pursuits in domestic settings. Piccolo et al. (2007) proposed recommendations to help designers with accessibility issues for iDTV applications. Kunert (2009) proposed a collection of pattern for the iDTV focused in usability issues. Solano et al. (2011) presented a set of guidelines that should be considered in iDTV applications for preventing frequent usability problems.

Focused on the users' aspects, Rice and Alm (2008) proposed methodologies and interactive practices influenced by the Participatory Design (PD) to design solutions for supporting elderly people to interact with iDTV. Bernhaupt et al. (2010), in turn, used the Cultural Probes Method to conduct ethnographic studies in order to understand users' media behavior and expectations, indicating trends concerned with personalization, privacy, security and communication.

Focusing on the broadcaster company's aspects, some works have adapted traditional methodologies for software development (Gawlinski, 2003) and Agile Methods (Veiga, 2006) to the companies' production chain. The adapted methodologies encompass the entire software development process (e.g., requirement analysis, project, implementation, testing and support); although robust in terms of the technical process of software development, end users are usually not considered in the process.

For TV broadcaster companies, the design of interactive applications is a new component into their production chains. Veiga (2006) argues that designing iDTV applications is hardly supported by existing methodologies (e.g., Cascade Model) because it is different from designing traditional software systems (e.g., desktop, web). Furthermore, Kunert (2009) highlights that every emergent technology suffers from a lack of references, processes and artifacts for supporting their design. Therefore, new simple techniques and artifacts that fit broadcasters' production chain and explore the challenge of designing applications within the broadcasters' context are welcome.

Shedding light on this scenario, we draw on Socially Aware Computing (Baranauskas, 2009), Organizational Semiotics theory (Liu, 2000), Participatory Design (Müller et al., 1997), and Design Patterns for iDTV applications (Kunert, 2009) to propose three situated and participatory practices for supporting designers to create and evaluate iDTV applications: i) the Participatory Pattern Cards; ii) the Pattern-guided Braindrawing; and iii) the Participatory Situated Evaluation.

In this paper, we present the three practices and the theories underlying them, and discuss the results obtained from their usage in the practical context of a Brazilian broadcasting company. The practices were planned to facilitate the participation of professionals from the TV domain that are not familiar with iDTV applications design. A group of 9 persons, with different profiles, participated in design workshops for creating an iDTV application for one of the company's programs. The results suggest both the practices' usefulness for supporting design activities and the benefits of situated and participatory design for iDTV applications, indicating the viability of conducting the practices in industrial settings.

The paper is organized as follows: the Section 2 introduces the theories and methodologies that ground our work. Section 3 describes the new practices created for supporting a situated and participatory design of iDTV applications. Section 4 presents the case study in which the techniques were applied, and Section 5 presents and discusses the findings from the case study analysis. Finally, Section 6 presents our final considerations and directions for future research.

2 THEORETICAL AND METHODOLOGICAL FOUNDATION

Organizational Semiotics (OS) and Participatory Design (PD) are two disciplines which represent the philosophical basis for the design approach considered in this work. Design patterns for iDTV add to this theoretical basis contributing to shaping the design product.

OS proposes a comprehensive study of organizations at different levels of formalization (informal, formal, and technical), and their interdependencies. OS understands that all organized behavior is effected through the communication and interpretation of signs by people, individually and in groups (Stamper et al., 2000; Liu, 2000). In this sense, the OS supports the understanding of the context in which the technical system is/will be inserted and the main forces that direct or indirectly act on it. If an information system is to be built for an organization, the understanding of organizational functions from the informal to the technical level is essential (Liu, 2000).

The PD, originated in the 70's in Norway, had the goal of giving to workers the rights to participate

in design decisions regarding the use of new technologies in the workplace (Müller et al., 1997). In this sense, PD proposes conditions for user participation during the design process of software systems. PD makes use of simple practices that use fewer resources (e.g., pen and paper), and considers that everyone involved in a design situation is capable of contributing, regardless of his/her role, hierarchical level, and socio-economic conditions. Two examples of participatory practices are Brainwriting (VanGundy, 1983) and Braindrawing (Müller et al., 1997). Both practices are examples of cyclical brainstorming conducted to generate ideas and perspectives from various participants for the system to be built. While Brainwriting was created to generate ideas for system features, Braindrawing was proposed for generating graphical ideas for the User Interface (UI).

Drawing on OS and PD, the Socially Aware Computing (SAC) proposes to understand the design cycle by working on the informal, formal and technical issues in a systematic way; moreover, it recognizes the value of participatory practices to understand the situated character of design.

2.1 Socially Aware Computing

The Socially Aware Computing (SAC) is a socially motivated approach to design (Baranauskas, 2009) that 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 effectively meet the sociotechnical needs of a particular group or organization.

Considering the Semiotic Onion (Figure 1), SAC understands design as a process that must go through the informal, formal and technical layers cyclically — see the dashed cycle. According to Baranauskas (2009), the design process should be understood as a movement that starts in the society (outside of the semiotic onion) and progresses through the informal and formal layers in order to build the technical system. Once (an increment of) the technical system is projected, the movement returns impacting on formal and informal layers alike, including the people for whom the system was designed, the environment in which it is/will be inserted, and the society in general. SAC is an iterative and incremental process. Therefore, each iteration favors the problem clarification, knowledge-building, and the design and evaluation of the proposed solution.

For understanding the organization's situational context and the system inside it, SAC uses concepts and techniques inspired by PD and OS. More than the end user, SAC considers and involves key stakeholders and heterogeneous groups of people who may influence and/or may be influenced by the problem being discussed and/or the solution to be designed.

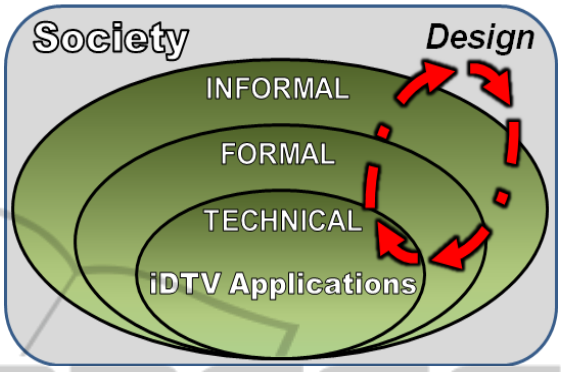

Figure 1: SAC's meta-model for design.

The practices conducted in SAC are held throughout the design process within Semio-participatory Workshops (SpW). According to Baranauskas (2013), each SpW has well-defined goals and rules within the design process, such as: i) socialization and personal introductions of the participants. ii) explanations about the SpW to be conducted, its concepts and objectives. iii) the role of the SpW in a whole design process (in the cases where there are more than one SpW to be conducted). iv) a well-defined schedule for activities. v) artifacts and methods created/adapted to be articulated with the practices, and so on.

SAC has been used to support design in several different contexts, being applied in design scenarios of high diversity of users (e.g., skills, knowledge, age, gender, special needs, literacy, intentions, values, beliefs) and to create different design products in both academic and industrial environments (Pereira, 2013). Specifically for the iDTV context, SAC has being used to support the consideration of stakeholders' values and culture during the design process (Pereira et al., 2012), for proposing requirements and recommendations to iDTV applications (Piccolo et al., 2007), and to physical interaction devices (Miranda et al., 2010).

2.2 Design Patterns for iDTV

Design patterns were originally proposed to capture the essence of successful solutions to recurring problems of architectural projects in a given context (Alexander, 1979). In addition to their use in the original field of architecture, design patterns have

been used in other fields, such as Software Engineering (Gamma et al., 1995) and Human-Computer Interaction (HCI) (Borchers, 2001), as well as within different contexts, such as Ubiquitous Computing (Chung et al., 2004) and iDTV (Kunert, 2009).

For new technologies, Kunert (2009) and Chung et al. (2004) argue that design patterns present advantages: i) they are distributed within a hierarchical structure, which makes it easier to locate and differentiate between patterns of different granularity; ii) they are proposed in a simple language; and iii) they incorporate references that may indicate other forms of design guidance.

In the iDTV field, few studies proposing HCI patterns are found in literature. For instance, Sousa et al. (2006) previously identified a list of usability patterns for specific interactive iDTV tasks, and Kunert (2009) proposed a pattern collection that focuses on interaction design for iDTV applications, paying special attention to usability issues.

The pattern collection used in this work is the one proposed by Kunert (2009). The patterns are divided into 10 groups: **Group A**: Page Layout — Defines the layout types to be used in the application; **Group B**: Navigation — Defines what types of navigation are to be used in the application; **Group C**: Remote Control Keys — Defines the main keys of the remote control; **Group D**: Basic Functions — Highlights the basic functions that should be considered in the design of interaction; **Group E**: Content Presentation — Determines the basic elements that form an application; **Group F**: User Participation — Describes the interaction of specific tasks; and the way how the approval for connectivity should be handled; **Group G**: Text Input — Defines the multiple ways to input text, when to use each, and how to use them in an application; **Group H**: Help — Defines the types of help and how to provide them for users in an appropriate way, according to the context of use; **Group I**: Accessibility & Personalization — Deals with accessibility and personalization issues; and **Group J**: Specific User Groups — Illustrates patterns for specific user groups (e.g., children). Each of the 10 groups describes and illustrates first-level problems that are divided into new design problems of second and third levels. On the second level, there are 35 interaction problems; for each one, there is a corresponding pattern.

A pattern must follow a structure that is inherent to the purpose of the language or to the set of patterns on which it is inserted (Borchers, 2001). Kunert's iDTV patterns are characterized by: 1. **Reference**: a unique identifier in the pattern collection; 2. **Name**: usually describes the effect of using the pattern (e.g., "Full-Screen without Video"); 3. **Examples**: forms to use the pattern (e.g., images that illustrate the pattern being used); 4. **Context**: an introductory paragraph contextualizing the use of the pattern; 5. **Problem**: shows the forces involved in the use of the pattern, aspects to be considered, etc. 6. **Solution**: different and generic ways of solving the problem; 7. **Evidence**: references and usability tests used to demonstrate the viability of the proposed solutions; 8. **Related Patterns**: patterns that influence and/or are influenced by the pattern in question.

There is not a strict order when choosing patterns, however, Kunert (2009) suggests choosing the layout and navigation patterns before the other patterns, because this initial decision directly influences the remaining ones.

3 THE PROPOSED PARTICIPATORY PRACTICES

Drawing on the design patterns and the participatory design techniques, we proposed three practices for supporting design activities in a situated context: i) Participatory Pattern Cards; ii) Pattern-guided Braindrawing; and iii) Participatory Situated Evaluation. These practices were articulated with other design activities in an instantiation of Baranauskas' SAC design process (2009) in order to favor the situated and participatory design of iDTV applications — see Figure 2.

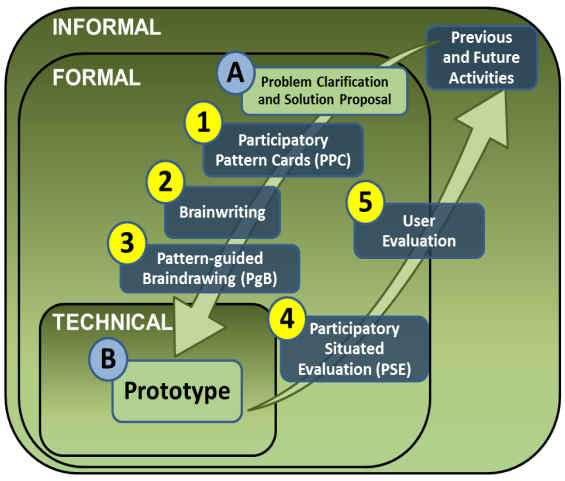

Figure 2: Design process.

The "A" detail in Figure 2 suggests that the

problem domain must be clarified and a solution proposal must be discussed in a participatory way before engaging in further design activities. When the problem is clarified and a solution is proposed, three participatory practices ("1", "2" and "3" details) support the production of the first version of the prototype ("B" detail); one participatory practice supports the inspection of the designed prototype ("4" detail), and one extra evaluation may be conducted with prospective end-users ("5" detail). These activities contribute to build and evaluate a prototype for the application, offering useful information for further iterations of the process (e.g., the codification stage, the design of new functionalities, redesign).

The **Participatory Pattern Cards** (PPC) ("1" detail in Figure 2) was conceived to support discussions about design patterns for the iDTV, and the identification and selection of the patterns suitable for the application being designed. For this practice, we created 34 cards based on Kunert's (2009) Design Patterns for the iDTV. Table 1 presents a description for the practice.

Figure 3 illustrates an example of a Pattern Card created for the practice. Each card has the following sections: i) group, reference and name of the pattern,

Table 1: Description of the PPC practice.

Participatory Pattern Cards (PPC)	
Materials (input)	1. A set of 34 cards representing Kunert's collection of patterns: the cards are organized in 5 predefined groups (e.g., patterns for the application's layout; patterns for the text input mode); 2. All the material produced in previous activities (e.g., a brief description of the design problem, a general description of a solution proposal, a list of requirements).
Methodology	1. Cards overview: participants are introduced to the Pattern Cards, their different types and usage examples; 2. Selection of patterns: for each card group, participants should individually select the cards that would potentially be used in the application. 3. Consensus: a brainstorming section where the participants present the selected patterns and discuss the pros and cons of each one in order to decide the ones they will adopt; 4. Justification for the choices: once a consensus was reached, participants must justify their choices based on the project's scope and requirements.
Results (output)	1. A subset of patterns that will potentially be used for the application. As byproducts, the practice: i) brings participants closer to the iDTV domain; ii) draws attention to the limited resources and technology that will be provided for the system to be designed; and iii) may inspire design ideas for future projects.

ii) an example of the pattern being used in a given situation; iii) a brief description of the problem; iv) forces (advantages and disadvantages) that act directly and indirectly on the problem to be solved; and v) the solution to the problem.

The PPC practice is useful to clarify the constraints and potentials of iDTV technology and to choose design patterns in a participatory way, contributing to the construction of a shared knowledge among the participants.

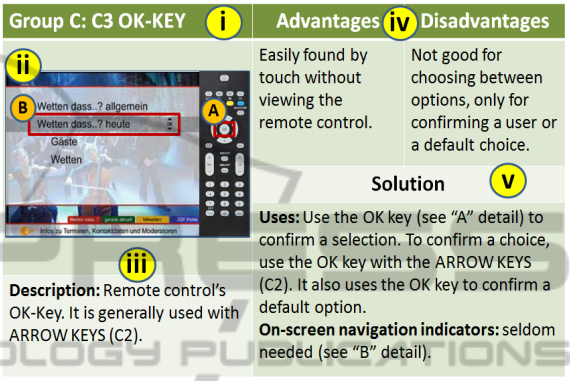

Figure 3: Example of a Pattern Card created from Kunert's (2009) collection of patterns.

The **Brainwriting** ("2" detail in Figure 2) is a silent and written generation of ideas by a group in which participants are asked to write ideas on a paper sheet during a pre-defined time (e.g., 60 seconds). Once this time was elapsed, each participant gives his/her paper sheet with ideas to other participant and receives another paper sheet to continue the ideas written on it. This process is repeated several times until a predefined criterion is satisfied — e.g., the fixed time has run out; each paper sheet passed by all the participants (Wilson, 2013). On the one hand, Brainwritting is a good method for producing different ideas in a parallel way, allowing the participation of all without inhibition from other participants. On the other hand, it focuses on the question/problem being discussed rather than on the person discussing it (VanGundy, 1983), avoiding conflicts between the participants.

The **Pattern-guided Braindrawing** (PgB) ("3" detail in Figure 2) is an adapted version of Braindrawing that aims to generate ideas for the UI of the application being designed, taking into account the Design Patterns for iDTV. Table 2 presents a description for the technique.

The PgB allies the benefits from PD and Design Patterns, being useful to materialize the ideas and proposals produced in the previous steps into prototypes for the application. Therefore, while the

participatory nature of both PPC and PgB techniques motivates participants to generate design ideas that rely on the perspectives of different stakeholders, the use of Design Patterns informs these ideas and guides their materialization.

Table 2: Description of the PgB practice.

Pattern-guided Braindrawing (PgB)	
Materials (input)	Paper sheets for drawing, colored pens, chronometer.
Methodology	1. Situating: participants are arranged in a circle; the design problem and the results from the previous activities (e.g., requirements, PPC) are briefly reviewed; 2. Generation of design elements: keeping visible the design patterns selected in the PPC and a list of requirements for the application, participants start drawing the application's interface on a paper sheet. After a pre-defined time (e.g., 60 seconds), participants stop drawing, move the paper sheet to the colleague seated on their right side, and receive a paper sheet from a colleague seated on their left side, continuing to draw on the received paper sheet. This step repeats until all participants contributed with ideas to all the paper sheets at last once, i.e., a complete cycle; 3. Synthesis of design elements: From their own paper sheets (the ones the participants initiated the drawing), participants highlight the design elements that appeared in their draws and that they find relevant for the application. 4. Consensus: Based on the highlighted design elements from each paper sheet, the group synthesizes the ideas and consolidates a final proposal that may include elements from all the participants;
Results (output)	1. Different UI proposals that were created in the participatory activity: each proposal presents elements drawn by different participants, differing from each other because they were started by a different person; 2. A collaborative proposal for the application's UI, guided by design patterns, and created from the consolidation of the different proposals by the participants.

A picture of a television device and a screenshot of the TV program may be used as background of the paper sheets used in PgB — as illustrated in Figure 4. This contributes to bring reality to the participants during the activity, situating them according to the device's physical limitations, the program layout and content.

Figure 4: Example of a template for the PgB.

The third practice created was the **Participatory Situated Evaluation** (PSE) ("4" detail in Figure 2). The PSE is an adapted version of Thinking Aloud method (Lewis, 1982) that aims to bring together all participants for the evaluation of an iterative application — Table 3 presents a description for the practice. This practice is useful to promote a collective analysis and discussion about the produced prototype; to identify shared doubts and difficulties, as well as ideas for improving the application. It avoids the prevalence of individual opinions, favoring the collective discussion and making sense about the application being evaluated, and optimizing the time spent by the participants during the activity.

Table 3: Description of the PSE practice.

Participatory Situated Evaluation (PSE)	
Materials (input)	Laptop, interactive prototype, video camera, and software to record users interacting with the prototypes.
Methodology	1. Situating: participants are arranged in a circle; the interactive prototype is introduced to the participants and the evaluation activity is explained; participants can either conduct pre-defined tasks (e.g., voting in a pool) or explore the application in a free way; 2. Interacting with the prototype: a participant is invited to interact with the prototype; using the Thinking Aloud method (Lewis, 1982), the participant speaks aloud for the group while interacts with the prototype, reporting his/her thoughts (e.g., general impressions about the prototype, intentions, goals, difficulties, questions, reasoning). The other participants can talk to each other and to the person who is interacting with the prototype, speaking their thoughts alike. 3. Consensus: based on the doubts, ideas, feelings and difficulties found during the activity, the participants elaborate a list of problems and suggestions for improving the application.
Results (output)	1. A mapping of the interaction and interface problems identified through the activity; 2. Suggestions of improvements presented in the group's suggestion list.

User Evaluation ("5" detail in Figure 2) proposal: the Thinking Aloud technique (Lewis, 1982) can be used to capture users' impressions and opinions. The participants' interaction, voices and facial

expressions can be recorded, and participants may be invited to answer an evaluation questionnaire, providing their overall impressions about the prototype. The activity and data usage should be conducted in accordance to ethical principles in academic research.

4 THE CASE STUDY

The case study was conducted in a real context of a television broadcasting company, named EPTV (Portuguese acronym for "Pioneer Broadcasting Television Stations"). EPTV is affiliate of a large Brazilian broadcasting company. Currently, EPTV programming reaches more than 10 million citizens living in a microregion of about 300 cities (EPTV, 2014).

"*Terra da Gente*" (TdG, "Our Land", in English) is one of several programs produced by EPTV. The program explores local diversity in flora and fauna, cooking, traditional music, and sport fishing. Currently, the program runs weekly and is structured in 4 blocks of 8 to 10 minutes each. It counts on a team of editors, writers, producers, designers, technicians, engineers and journalists, among other staff members. In addition to the television program, the TdG team also produces a printed magazine and maintains a web portal. Both the magazine and the web portal serve as complementary sources of material for the TdG audience (TdG, 2014).

The activities reported in this paper were conducted from January to July, 2013, and involved 3 researchers from Computer Science and 6 participants playing different roles at EPTV:

- **TdG Chief Editor:** is the person who coordinates the production team (e.g., editors, content producers, journalists, designers, etc.) of the television program and the web portal.
- **Designer:** is the responsible for the graphic art of the television program as well as of the web portal, and who will be responsible for the graphic art of the iDTV application.
- **Operational and Technological Development Manager**: is the person who coordinates the department of new technologies for content production.
- **Supervisor of Development and Projects**: is the person who coordinates the staff in the identification and implementation of new technologies for content production and transmission.
- **Engineer on Technological and Operational Development**: is the engineer of infrastructure, and content production and distribution.
- **Technical on Technological and Operational Development**: is the person responsible for the implementation, support and maintenance of production systems and content distribution.
- **Researchers (3 people):** are researchers in Human-Computer Interaction and the responsible for preparing and conducting the workshops. One of them is expert in the SAC approach and other is an expert in iDTV technologies.

All the participants, except for the researchers, work in the television industry. The participants (P1, P2...P9) collaborated in the workshops proposed to the problem clarification, problem solving, requirement prospecting, as well as the creation of prototypes for the application and their evaluation, within a SAC approach.

Regarding the familiarity of participants with iDTV applications, from the 9 participants, 2 are experts; 2 are users of applications; 5 participants had already used/seen iDTV applications. Regarding the frequency which the participants watch the TdG program, 5 participants have been watching the TdG program, but not very often: 1 participant watches the program every week, 1 participant watches the program in average twice a month, and 2 participants watch at least once a month.

4.1 Designing an Application for TDG

This section presents the main activities conducted to create the first prototype of an iDTV application for the TdG program. Before these activities, participants had collaborated for the problem understanding, and for the clarification, analysis and organization of requirements for the application to be designed — as proposed by the SAC approach, and that are out of scope of this paper ("A" detail in Figure 2). The materials produced by the previous activities were used as input for the design activities presented in this paper, and were reported in (Buchdid et al., 2014).

Before the beginning of 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. For instance, before the PPC activity, examples of different existing iDTV applications, and the patterns from Kunert (2009), were briefly presented and discussed with the participants.

The **PPC** activity was the first participatory practice conducted to design the application

prototype ("1" detail in Figure 2). Its input were the documentation produced in the problem clarification activities, the participant's knowledge about the project, and Pattern Cards based on the Kunert's patterns (2009) — see Figure 5.

Originally classified into 10 different categories (from "A" to "J"), the patterns were grouped into 5 major groups in order to facilitate the participants' understanding: 1. Layout (Group A); 2. Navigation (Group B); 3. Operation (Groups C, D and G); 4. Content presentation (Groups E and F); and 5. Help, accessibility and personalization (Groups H and I). Patterns such as "B3 Video Multi-Screen" and "J1 Children" were not considered because they were out of the projects' scope.

Figure 5: Participants holding Pattern Cards.

The dynamic for this practice followed the description presented in Table 1. While each group of pattern was presented and discussed, participants were asked to select the ones that would potentially be used in the application. This practice lasted 90 minutes and was important to generate discussion and ideas to the application; they also led to a shared knowledge about iDTV potentialities and limitations among the participants.

Guided by the discussions and the results identified in the PPC practice, the **Brainwriting** ("2" detail in Figure 2) was used to identify what the participants wanted in the application and what they thought the application should have/be. The dynamic for this activity is similar to the PgB presented in Table 2: each participant received a paper sheet with the following sentence: "I would like that the "*Terra da Gente*" application had..."; the participants should write their initial ideas and, after a pre-defined time (e.g., 60 seconds), they should exchange the paper sheets and continue to write on the ideas initiated by the other participants. After each paper sheet had passed by all the participants and returned to the one who started writing the idea, participants should highlight the concepts that appeared in their paper sheet, and expose them to the group for discussion. The group reached a consensus creating a list of the main functionalities that should appear in application. This activity took 90 minutes.

The **PgB** practice was conducted based on the ideas generated during the Brainwriting and took into account the patterns selected in the PPC (see "3" detail in Figure 2). The dynamic for this activity is presented in Table 2: each participant received a template in a paper sheet (see Figure 4), and they were asked to explore the initial call for the application, the layout and other specific content that they would like to see in the application. Participants started drawing the application interface, exchanging their paper sheets periodically and continuing to draw on the paper sheets of the other participants until they received their paper sheet back. This activity generated several ideas for the iDTV application that were consolidated by the team in a final proposal. This activity lasted 30 minutes.

Based on the results obtained from these activities, the first prototype for the application was built ("B" detail in Figure 2) by a researcher who has experience in the development of iDTV applications. The *Balsamiq*® tool was used to create the UI and the *CogTool*® was used to model the tasks and to create an interactive prototype. The Pattern Cards were used again in order to inspect whether the application was in accordance with the design patterns, guiding the layout definition (e.g., font, elements size and position, visual arrangement of these elements) and interaction mechanisms (e.g., remote control's keys that were used).

The **PSE** was conducted in order to evaluate the produced prototype — "4" detail in Figure 2. The activity was conducted according to the structure presented in Table 3. The interactive prototype was presented to the participants, and one of them explored the application using the "Thinking Aloud" technique. The other participants observed the interaction, took notes, and were able to ask, suggest and discuss with the evaluator at any time. Both the user interaction and the group dynamic were recorded, providing interesting information about the general perception of the participants and possible features to be redesigned before programming the final application. This practice lasted 50 minutes and, after concluded, participants answered a questionnaire evaluating the prototype.

Finally, a **User Evaluation** was conducted in order to evaluate the prototype with prospective representatives from the target audience that did not participate in design activities — "5" detail in Figure 2. This activity was important to serve as a

parameter to the PSE evaluation, assessing whether the prototype made sense to a more diverse audience. For this activity, 10 participants explored the prototype: 3 participants are 21-30 years old, 5 are 31-40 years old, 1 is 41-50 years old, and 1 participant is over 60 years old. Regarding their formal education, from the 10 participants: 1 has high school, 3 have bachelor's degree, 1 has specialization course, 3 have master's degree and 1 participant has a doctor's degree. None participant had previous experience using iDTV applications; 8 participants were aware of them, but had never seen any application; and 2 participants had seen them before. Furthermore, from the 10 participants, 6 have been watching the TdG program, but not often; 3 participants watch once a month; and 1 participant do not watch TdG.

5 RESULTS AND DISCUSSION

In this section, we present and discuss the main results from the practices we proposed in this paper to create the interactive prototype for the TdG TV program.

5.1 Results of Design Practices

During **the PPC practice**, the participants selected 20 patterns that could be used in the application design. At least one pattern from each group of patterns was considered by the participants. Table 4 presents some of the patterns selected by the participants. The "Groups" column presents the general group of the selected pattern; the "Patterns" column presents the name of the pattern; the "PPC" column indicates whether the pattern was selected during the PPC practice; the "Explanation" column explains the reason why the pattern was selected; and the "PgB" column indicated whether the pattern was identified in the prototype produced in the Brain-Drawing practice.

Table 4: List of Patterns used in the activities.

Groups	Patterns	PPC	Explanation	PgB
Operation	C3 Ok-key	✔	It must be the main method of interaction together with arrow keys	✔
	C4 Colour keys	✔	To be used in case of voting and multiple-choice question	✔
	C5 Number keys		Would not be used due to the difficulty of use	
	C6 Special keys		Hard to find on remote control	✔
	D1 Initial call to action	✔	An unobtrusive call that does not disturb who does not want to use the application	✔
	…	…	…	..
	G3 Mobile phone keyboard	✔	Must not occupy much space on the screen. It will only be used in case of text input	
Help and cia	H1 On-Screen instruction		It is not necessary because the application is simple	✔
	H2 Help section	✔	Help only in the Option menu	✔
	I1 Accessibility	✔	Universal Design	
	I2 Personalisation		It is very sophisticated to this kind of application	

For instance, the pattern "C3 Ok-key" was selected to be "*the main interaction method together with arrow keys*" in the PPC practice, and was identified in the prototype produced in the PgB. The pattern "C6 Special keys", in turn, was not selected in the PPC, but appeared in the prototype created by the participants: It can be partially explained by the fact that the participants got more used to the patterns and may have perceived the need/benefits of patterns they did not select during the PPC. Therefore, this is both an indication that the PPC does not narrow the participants' views during the creation of prototypes, and an evidence that the PgB facilitates the revision of the selected patterns during the creation of prototypes.

From **the Brainwritting practice**, 11 concepts were created to be included in the application: 1. Gallery/Making of: pictures from the TV program and information about the backstage; 2. Localization/Mapp: geographic coordinates of the place in which the TV program was recorded; additional information about roads, flights, trains, etc. 3. Receipt/Ingredients: it presents the ingredients of the receipt that will be prepared during the TV program. 4. Information/Curiosity: offers information and curiosities about the fauna and flora existing in the place where the TV program was recorded. 5. Evaluation Pool: a pool that allows users to answer whether they liked the program they are watching. 6. Quiz: a question-answer based-game about subjects directly related to the TV program content. 7. Fishing Game: a ludic game intended to keep users' attention through a virtual fishing while they watch the TV program (e.g., a little fish will appear on the screen and the user must select a different key to fish it). 8. Fisherman Story: a specific Quiz that allow users to answer whether a given story is true or false. 9. Abstract: a summary of the current TV program. 10. Prospection Pool: a pool that allows users to vote in the subjected that will be presented in the next program. 11. Chat: asynchronous communication on the TV program.

The first 6 concepts were selected to be used in the **PgB** activity. In addition, the participants were invited to explore ideas to application's trigger

(Pattern: "DI Initial Call to Action") in the same activity. The other concepts were not considered because they were similar to a selected concept (e.g., Fisherman Story is similar to the Quiz), because they were considered uninteresting (e.g., Summary), or because they would require high attention and cognitive effort to be used (e.g., Chat).

All the six selected concepts appeared in the individual prototypes created by the participants of the PgB practice as well as in the final prototype consolidated by the participants. For instance, the "Gallery/Making of" concept appeared in 7 individual prototypes (see the column "Frequency" in Table 5), and was represented in 4 different forms (column "Forms"). The 9 individual prototypes also represented the "Localization/Mapp" concept in 4 different forms. Furthermore, the "Fishing Game" appeared 3 times even not being one of the chosen concepts; indicating that the activity favored the appearance of different and diverse ideas.

Table 5: List of concepts represented in the individual prototypes.

Concept	Frequency	Forms
Gallery/Making Of	7	4
Localization/Mapp	9	4
Receipt/Ingredients	7	4
Information/Curiosities	7	4
Evaluation Pool	5	3
Quiz	5	3
Application's Trigger	6	6
Fishing Game	3	3

The individual prototypes generated in the PgB were consolidated into a final prototype that, in turn, was used as the basis for creating an interactive prototype for the TdG iDTV application. The six concepts cited previously, as well as the patterns presented in Table 4, and general ideas elaborated by the participants were reflected in the interactive prototype. The Figure 6 presents details indicating attributes and components of the final prototype produced by the participants that were reflected in the interactive prototype created by the researchers. For instance, the logo ("A" detail) and menu position ("B" detail); the selected remote control keys and their positions on screen ("C"); and the content for each application section ("D").

The design patterns selected in the PPC practice were reflected in both the final prototype produced by the participants and the interactive prototype created by the researcher. For instance, the patterns "C4 Colour keys" and "H2 Help section" were selected in the PPC activity and were considered in

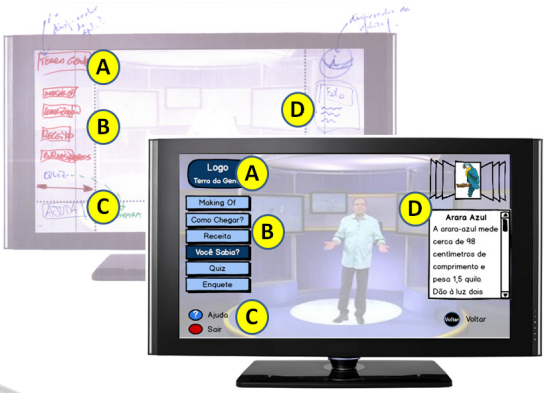

Figure 6: Example of attributes and components generated through the PgB practice.

the individual prototypes — see Table 4, and were also considered in the interactive prototype — see details "C4" and "H2" in Figure 7.

5.2 Results of the Evaluation Practices

Both the PSE and the evaluation with prospective representatives from the audience produced suggestions for redesigning the interactive prototype. For instance, during the PSE it was identified that users could leave the application at any moment/any level of interaction; however, the evaluation indicated that it could cause interaction problems, such as the user accidentally leaving the application while trying to see a picture from the backstage. The participants recommended disabling the "Exit" functions when the user enters in a second level menu/function. Furthermore, the "Help" function also should be applied only to the general application (not in specific sub-menus), because the application is very easy to use and the button could disturb the user in specific activities.

Other useful feedbacks were obtained from the PSE practice, such as the suggestion to use numbers in the pool's options in order to facilitate the selection, and not confuse users with other application's functions that use colors key; and the recommendation to not deploy the "Quiz" and the "Pool" features simultaneously in the application in order to not overload users with similar features.

The participant who explored the interactive prototype in the PSE practice was clearly pleased for not having difficulties while using it, highlighting the simplicity and consistency of the interactive prototype. Using his words: *"(...) if even me was able to understand and use the prototype, then it means the prototype is very intuitive*." [laughs] — he had never used an iDTV application before.

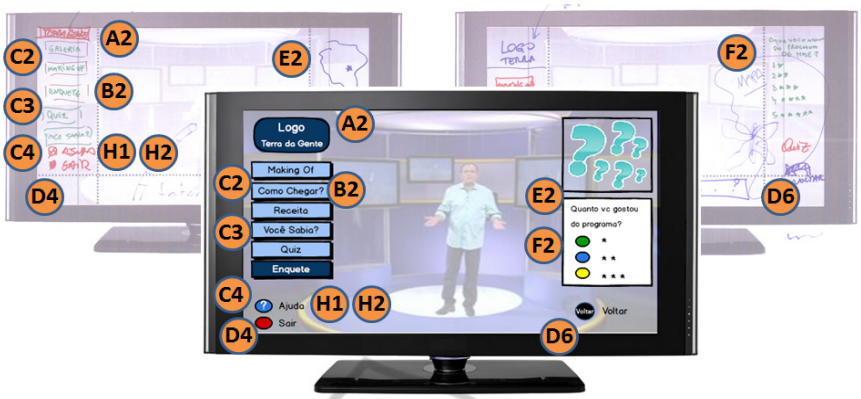

Figure 7: Patterns highlighted on the mockups from the PgB and on the final prototype.

The participants' responses to the evaluation questionnaire also indicated a positive opinion about the interactive prototype. From the 9 participants who answered the questionnaire, 7 (78%) responded they really liked the prototype, and 2 (22%) answered that they liked moderately. No indifferent or negative response was provided, indicating that the prototype met the participants' expectations.

The test with representatives from the audience reinforced a favorable opinion about the interactive prototype. The 10 prospective users were able to understand and explore the prototype, indicating its simplicity. From their responses to the evaluation questionnaire, 5 users (50%) answered they really liked the prototype, 4 users (40%) answered they liked moderately, and 1 users (10%) answered with indifference. Although we need to test the application with a higher number of users in order to have data with statistical relevance, obtaining 90% of positive responses is a good indication given that they did not participate in design activities and had no prior contact with iDTV applications.

5.3 Discussion

During the participatory practices, the constructive nature of the process allowed to see how different viewpoints were conciliated, different proposals were consolidated, a shared understanding about the problem domain and the application was created, and how the discussions were materialized into a solution proposal. Ideas and concepts that were discussed when the project started could be perceived during the practices and were reflected in the final prototype.

The interactive prototype reflected the results from both PPC and PgB practices, allowing the participants to interact with the prototype of the application they co-created. The examples of existing applications presented to the participants were useful to illustrate different solutions regarding the patterns, inspiring the design of the new application and avoiding design decisions that would not satisfy them. The PPC practice was especially useful to: i) present the constraints, limitations and challenges of designing for iDTV; and ii) introduce participants to design patterns for iDTV, which may support their design decisions.

The PgB, in turn, was useful for supporting a pattern-guided construction of UI proposals for the application from the material produced in the previous activities. This practice is especially important because it favored the consideration of Design Patterns in the prototype design, and because it allowed all the participants to expose their ideas and to influence the prototype being designed, avoiding the dominance of a single viewpoint. For instance, the "Pool" and the "Quiz" were concepts that emerged from the Brainwritting and were materialized during the PgB practice, but were strongly discussed among the participants because some of them did not approve these features. However, after listening pros and cons of keeping/removing these concepts from the project's scope, the participants decided to keep both concepts in the final prototype.

One of the most important points in this project is its situated context. The conduction of participatory practices in a situated context contributed to understand different forces related to the project and the organization in which it was being conducted. In each new practice, it was possible to clarify tensions between the participants, the context in which the EPTV operates, the high importance of the TdG program for EPTV organization, the relation between the affiliate and its headquarter and, mainly, the role that the application may play in the TV program.

Participants have different views and understandings regarding the competition (for the user attention) between the application and the TV program, and different opinions about what the application should offer to users and the way it should be offered. Such complex context would be difficult to understand in a non-situated design, and such conflicts would be hard to deal with if participatory practices were not part of the methodology.

Regarding the prototype evaluation, the PSE was important to foment discussions on the design decisions. Furthermore, the feedback from prospective users was important to verify decisions made with outsiders: people who did not participate in the design process (e.g., how to present the recipe: only the ingredients should be included? The preparation mode should also be displayed?).

The practices reported in this paper demonstrate that it is possible to conduct situated and participatory design in industrial settings. There is usually a myth that these practices are expensive and difficult to be conducted. In fact, in less than 4 hours a prototype was built from the documentation produced in the previous practices and from the discussion between the participants — including the time spent to present examples of existing applications and the lecture for presenting the patterns. Some of the participants had a vague idea about how to design iDTV applications and none of them had designed this kind of application before.

Furthermore, the four workshops conducted at EPTV took about 12 hours. It means that all the process, from the problem clarification to the prototype evaluation, took them less than two days of work. It is clear that a great effort from the researchers was needed in order to summarize, analyze and prepare the practices as well as to prepare the presentations and build the interactive prototype. Indeed, this effort is expected because a lot of work must be done in parallel to the practices organization and conduction. Therefore, this experience shows that it is possible, viable and worth the time used to make participatory design in a situated context.

The experience at EPTV also indicated that a situated and participatory design contributes to the development of solutions that are in accordance to both the people directly involved in design practices and the prospective end users of the designed solution. On the one hand, the participatory evaluation indicated that the participants approved the interactive prototype they co-designed; it was expected because of the participatory and situated nature of the process conducted. On the other hand, the evaluation with representatives from the target audience reinforced the positive results, indicating that the application was understood and well accepted by users that were not present in design activities and that had never experienced an iDTV application before.

These results suggest that a situated and participatory design perspective favors the construction of solutions that make sense to people, reflecting an understanding about the problem domain and the complex social context in which these solutions will be used.

6 CONCLUSIONS

Designing iDTV applications is a complex activity due to several factors including the ecosystem of media that compete and cooperate with the TV. In addition, the production chains of the broadcasters are still not prepared to the design of iDTV applications. This paper proposed three different practices and presented activities for supporting a situated and participatory design of iDTV applications; a case study situated in real scenario of a TV organization illustrated the proposal in action.

The results obtained from the case study indicated the benefits of using the practices for supporting the involved parties to understand the situated context that the iDTV application will be inserted, and to design an application that reflects that understanding. The results suggested that the interactive prototype designed was widely accepted by both the participants and prospective end users, pointing out the situated and participatory process as a viable and useful perspective for designing iDTV applications.

Although the results so far are very positive, the prototype still needs to be broadcasted as an iDTV application in *Terra da Gente* TV show. Thus, further work involves the next steps of implementing and testing the final application and releasing it for use by the TV program viewers. We also intend to conduct further studies within the perspective of the Socially Aware Computing, to investigate the potential impact of the practices presented in this paper to the TV staff and iDTV end users.

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