Issues and Challenges in Coupling Tropos with User-Centred Design

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Abstract. Goal-oriented requirements engineering aims at eliciting, elaborating, structuring, specifying, analyzing and documenting functional and non-functional requirements. This activity must include the involvement of final users of the system across the whole process to reduce the risk of misunderstanding the domain, missing important details and to increase the final value of the product. User-Centred Design is an approach that focuses on the continuous communication between requirements engineers and stakeholders, thus distributing responsibilities of the decision process about the requirements.

In this paper we explore the issues and challenges of coupling User-Centred Design and Goal-Oriented methods as we experienced in a real project aiming at developing smart environment for nursing home to support medical and assistance staff.

1 Introduction

When facing the problem of designing technologies, two roads diverge in the wood: Requirements Engineering (RE) and User-Centred Design (UCD). Indeed, both approaches ground their processes in information about the people that are directly or indirectly involved by the technology that has to be developed. Yet, they not only have different set of techniques and incompatible vocabularies but also they are based on two diverging epistemological foundations. UCD practitioners shun from any formal method at risk of compromising the actual use of the knowledge gained in the field. On the other side, RE practitioners often loose contacts with real people because formalizations cannot easily be shared with them: user analysis thus becomes a single-player game rather than a meaningful dialogue with stakeholders.

The need of reconciliation was raised in our experience with a large research project aimed at developing a smart environment in nursing home as support to medical and assistance staff. Since the beginning, we adopted the Tropos methodology and encountered a well-known problem in requirement elicitation: the complexity of the domain makes it difficult not only to understand users' needs but also to discuss with them our understanding of the domain.

In parallel, we adopted a UCD approach, mainly based on contextual interviews: our aim was to elicit true needs by observing daily practices and not only prescribed regulations. Activity scenarios were sketched to test with users our

understanding of their working practices. The narrative form of scenarios and the use of fictional personas made easier the confrontation between the analysts and the stakeholders. Later on, those scenarios were augmented with our vision of the technology. Again, the narrative form made the communication easier for them to understand and discuss in a tangible way. The issue with this approach, again well known in literature, was the lack of formality in collecting and analyzing the results.

The contribution of this paper is the analysis of foundations for the integration of the two approaches without compromising their very nature: in the differences there lies the power of the integration and its risks. The practical experience of mediating these two perspectives represents the basis for a discussion of generic issues and challenges that arise for the integration of User-Centred Design and Goal-Oriented methods.

The paper is structured as follows: Section 2 introduces the practical experience that motivates the research objective; Section 3 is a discussion of challenges arising from generalizing the problem; finally in Section 4 conclusions and future works are reported.

2   Objective

Our general research objective is to maximize the connection between the very early stages of the domain analysis and requirements elicitation and the phase of their representation into semi-formal artifacts, such as goal-oriented techniques, to reason about them.

An initial approach to this coupling has been exploited in a real project and described in the next section. On the bases of the experience, our aim here is that of describing how, under what conditions and at what extent this experience can be generalized.

2.1   The Methodologies

The **Tropos methodology** [5] relies on a set of concepts, such as actors, goals, plans, resources, and dependencies to formally represent the knowledge about a domain and the system requirements. An actor represents an entity that has strategic goals and intentionality within the system or the organizational setting. Goals represent states of affairs an actor wants to achieve. A Plan is a means to realize a goal. Actors may depend on other actors to attain some goals or resources or for having plans executed.

User Centered Design. UCD is a design philosophy that exploits a number of different techniques within an iterative design process. Tenets of UCD are: early focus on users, tasks and environment, the active involvement of users in the design process, allocation of functions between user and system, the incorporation of user-derived feedbacks into system design, iterative design whereby a prototype is designed, tested and modified. UCD exploits a series of well-defined methods and techniques coming from social sciences and psychology for analysis, design, and evaluation technologies.
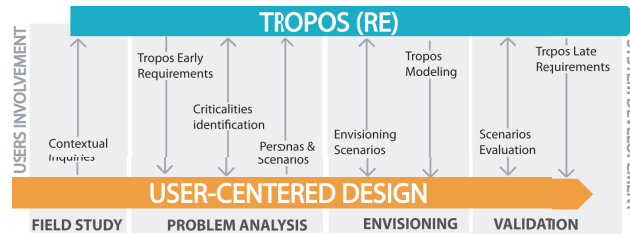
Fig. 1. Overview of the requirement elicitation process

2.2 The Experience: an Ambient Assisted Living System

The whole experience was articulated in seven phases all of them characterized by the use of both Tropos and UCD (see Figure 1).

Phase 1 - Field data collection. The process started with the investigation of the domain in order to understand the organizational setting in four nursing homes and to identify the needs of the stakeholders involved. In order to get rich insights about the context, we used contextual inquiry that demonstrated the capacity to satisfy the needs for a deep but at the same time rapid understanding of complex domain. Contextual inquiry consists in observing and interviewing people in their context, preferably when performing their tasks.

Phase 2 - Data Interpretation. The data interpretation is the step in which data coming from the domain is shared across the team and becomes knowledge. In our process, data interpretation is concurrently carried out: i) following contextual design approach dimension (flow model, sequence model, cultural model, artifact model, physical model) and ii) exploiting the early identification phase of Tropos.

Phase 3 - Problem analysis. The analysis of critical aspects was developed to highlight main problems that professionals of nursing homes experience in their job. The aim is to highlight every possible breakdown or problem that may occur in the organization that hinders the achievement of goals. A criticality relates an exceptional event to front with Tropos goals and tasks that are identified to receive a negative contribution. It also encapsulates the context in which the problem may occur.

Phase 4 - Personas and activity scenarios design. Introducing personas in scenarios-based approach provides an anchor against self- referentiality in design and make stories more concrete. We authored a set of activity scenarios — user stories about problems and criticalities identified through user studies.

Phase 5 - Envisioning, from data to design. The phase of envisioning exploited participative workshops in order to move from personas and activity scenarios identified in Phase 4 in order to envision how to introduce the technology in the analyzed domain. As a consequence of the envisioning focus group, and the introduction of the system into the goal-model, the Tropos process moved from the early requirement phase to the late requirement phase.

Phase 6 - From design ideas to Tropos modeling. Tropos diagrams and scenarios were jointly used to refine the ideas emerged during the creative workshops. On one hand, technological scenarios were designed to make design ideas concrete and to trigger reflection about possible services. On the other hand, Tropos diagrams were developed to more systematically analyze how the introduction of a system impacts on the domain actors.

Phase 7 - Evaluation of technological scenarios. Here visual scenarios were derived from the Tropos models and used for the validation phase (focus groups with stakeholders), where multiple views on the domain are required to drive the negotiation and refinement of requirements with stakeholders and project partners. If envisioning scenarios provided a concrete instance of a particular design solution, that is very helpful to discuss with stakeholders, on the other hand, Tropos diagrams aided designers in reconsidering design solutions and elaborating alternatives thanks to the possibility to trace back design solution to initial abstract requirements. The output of this phase was the agreement on early requirements and the refinement of Tropos late requirement diagrams.

3   Contribution: Integration Issues and Challenges

Crossing boundaries between two research approaches requires — borrowing a distinction from social sciences — either an assimilation or an integration process. In the case of assimilation, one approach must be modified to be assimilated into the other approach: while the risk is to loose the strength of the approach itself, the advantage is to work in a situation of methodological purity [6].

In the case of integration, as well as in our experience, practitioners should accept to work in a situation of methodological pluralism: the goal is not to transform a specific approach to make it fit into another one, but rather to bridge the gap between different research traditions and take advantages of their mutual strengths. Usually, the integration is more complex because practitioners work into different methodological traditions that have to be first understood to be integrated [7]. Integration, therefore, requires creating preconditions for a beneficial dialogue.

In the ACube project we recognized the irreducible cultural difference between the two approaches and therefore decided to work in a dialogic perspective, that is grounded on communication and iterative confrontation [4]. The following considerations come from generalizing the practical experience in coupling Tropos and UCD.

3.1   Epistemological challenge

The first issue is to consider epistemological foundations and validity criteria of both the approaches to manage the differences without weakening and distorting the two research paradigms. Whereas several methods employed in UCD derive from a constructivist perspective, many requirement engineer approaches are

grounded, instead, on a constructivist perspective — even if the debate on the positivist nature of many RE methods has recently been criticized [3].

Constructivism declares there is no single valid methodology and researchers play an active role in defining the reality. User-centered design is grounded on this research tradition: hence the scarce formality of methods, the subjective insights developed by practitioners, and the ambiguities in the analysis are, if correctly managed, not only accepted but actively perused [1].

Concerning the design activity, the *positivist* position suggests a rigid structure for the modeling activity and the reasoning process: while for constructivism, scientific knowledge is built by scientists, for positivism the knowledge is 'discovered' by the use of actual sense experience. The criticism on the positivist nature of goal-models relies on the semi-formality of such languages: there is no one 'right' goal model for describing a domain [3].

The integration challenge must consider these epistemological differences and be grounded on setting the pre-conditions to mediate these philosophical positions and generate a profitable dialogue between the two methods.

3.2 Linguistic Challenge

Near the methodological boundary, a linguistic boundary exists. The concurrent usage of both approaches requires that a common language exists in order to make a dialogue possible. For instance, several concepts exist in both Tropos and UCD that suggest an integration is possible and profitable; examples of these are the pairs of goal/need, actor/persona, task/activity; yet these terms have slight different meanings in the two methodologies that hinder the integration process.

The identification of a common language for coupling the methodologies must pass through a reconciliation of terms. Two alternatives are possible: (i) to create a unified meta-model of the integrated process, or (ii) to tie up terms with similar meanings while keeping them separate. The first way is fascinating but it presents some notable risks, such as, for instance, the loosing of the flexibility and expressivity of tools like personas and scenarios that often requires to be unbounded within precise frames. The second way is preferable but it requires an additional effort for creating a framework in which data of different nature can easily collaborate.

3.3 Lesson Learned

By recapping the design experience described in Section 2.2, we can recognize three main mechanisms that shaped the relationships and set the dialogue for an efficient cooperation between the two teams:

- Strengths/limits analysis: it relies on the identification of strengths and limits of both the methods while achieving a given design objective. This allows to define integration points between UCD and RE methods and take full advantages of their reciprocal strengths.

- Making the divides explicit: it consists in identifying barriers that may hinder the dialogue between the two methods. The anticipatory exploration of the barriers that can prevent a synergy between the two approaches was pursued.
- Mutual learning: social-based techniques may enable continuous information exchange and communication to overcame the linguistic barriers, to facilitate the negotiation of meanings and to share common modeling tools during the analysis activities.

4 Conclusions and Future Works

In this paper we addressed some of the challenges posed by a joint use of the human-centered and goal-oriented requirement engineering approaches, starting from the experience done within in a real ambient assisted living project. We discussed how a dialogic relationship between the disciplines may provide guidance for researchers from requirement engineering and human centered design field that cooperate within the same design process. In this perspective, the orchestration of different contributions, the establishment of communication practices and the engagement within a mutual learning process are presented as crucial steps to take full advantage of different research traditions. We finally made some hypothesis on how to generalize such an approach and discussed some issues related to this generalization.

In the future, we would like to explore in more details some issues emerged during the experience in the project and the subsequent discussions. In particular: from a methodological point of view we would like to explore the interaction of the two different approaches also exploiting principles form meta methodologies [2]; the other side we aim at refining the dialogue issues in linguistic interactions, also exploiting cognitive linguistics and ontology based approaches.

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