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Cooperation Modeling for Integrating Organizational Change into the System Development Process

Lahouaria Bendoukha
bendoukh@informatik.uni-hamburg.de

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Lahouaria Bendoukha
Hamburg University
bendoukh@informatik.uni-hamburg.de

Abstract

Cooperation modeling is crucial for the alignment of system development with the organizational change where the future system will operate. Since the nature of cooperative work and its changing are both knowledge-intensive and mediated through human decisions, traditional modeling approaches do not immediately provide concepts and techniques that are well suited for describing such alignment. We take advantage from "ontologies" research area to enrich semantically the representations of cooperative work enabling the generation of situated user-assisted cooperative processes meta-models. In this paper we propose an ontological framework (OFCP) where not only socio-technical aspects are taken into account in the system development life cycle, but also cognitive aspects informing the design of such systems.

Keywords: Requirements Analysis, System Development Life Cycle, Organizational Change, Cooperation Modeling, Ontology-based Modeling Approach

Introduction

The most crucial problem in cooperation modeling is to capture the changes the future system will initiate so that the system is keeping adaptable to the permanent changing environment where it will operate. These changes can be explicitly known such as those from the technological nature, or not as easily identifiable such as those from social nature. If many approaches are nowadays proposed for dealing with the alignment of organization, work practices and technological views for system development (Orlikowski et al., 1991; Wolf and Rosenblum, 1993; Floyd, Dittrich and Klischewski, 1999), we think that conceptual modeling, which is an important step in requirements analysis, is still missing a comprehensive and practical approach making this alignment explicit. The literature witnesses the emergence of manifold cooperation models based on different approaches (theories of situated action, Communities of practice, Distributed cognition, studies on coordination mechanisms and "articulation work", etc.). The different origins of those approaches lead to the fact that there is no consensus regarding the set of concepts and abstraction levels underlying the cooperation modeling.

We look for a modeling approach which first considers in addition to technical aspects also the social aspects by acknowledging the broad range of human work practices. Secondly, it considers that the cooperation support is itself an organizational change so that at least the factors of "structurally" open and closed work (Zacklad, 2003) must be considered at the early stage of work analysis. We believe that a practical solution ensures an alignment of organizational, human and operational contexts only when it is based on an adequate modeling technique enabling the integration of the cooperation's requirements from both user as well as developer points of view explicitly in the modeling process itself.

For this purpose, we have to extend and enrich semantically the cooperative work representation to make explicit technical, social and cognitive aspects of the cooperation. The objective of our research is to allow the semantic enrichment of cooperation modeling using ontologies enabling the generation of situated user-assisted cooperative processes meta-models. In this paper we propose an ontological framework (OFCP) where, not only socio-technical aspects are taken into account in the system development itself, but also cognitive aspects informing the design of such system.

Semantic Enrichment of the Representations of Cooperative Work

The most important reason for the difficulties in cooperation modeling is due to the fact that cooperation's requirements should be considered at different levels from different stakeholders. At least the difficulties encountered from user and developer points of view are identified:

- **Cooperation requirements from (system) user point of view***:* Social sciences studies have already revealed the open, ambiguous, tacit, and interactional nature of social and cooperative activities, which perhaps inevitably seem to be difficult to model. Traditional modeling techniques are not enough to model the unstructured, unusual, less tangible and unpredictable nature of cooperative processes (Ziegler, 2002).

- **Cooperation requirements from (system) developer point of view***:* System developers should not only develop a software system but also play a role of a real change agent in the organization where the system will operate (Floyd 1992). They should have continuously the whole overview which goes beyond the actual user's (s) requirements related to a specific actual situation of their nearby environment.

A semantic enrichment for cooperative work's representations is needed in order to integrate together the cooperation requirements from both developers and users points of view at the same level in the cooperation modeling process. We believe this is necessary for the alignment of system development with the organizational change.

Nowadays, "ontologies" are popular in several fields of informatics with their slightly generalized notion as '*Ontologies provide a shared and common understanding of a domain that can be communicated between people and application systems*' (Hensel, 2000). We consult the contribution of an ontology-based approach for cooperation modeling. Actually, it is agreed that foundational ontologies (FO) (Guarino, 2006) are in particular the most suitable for supporting an evolving community of users. They are ultimately devoted to facilitating mutual understanding and inter-interoperability among people and machines.

Ontological Framework as a Communication and Learning Artifact

An ontology-based cooperative work modeling approach for aligning system development and organizational change plays two important roles (See Figure 1):

- as a syntactic and semantic categorization of cooperation's knowledge structures, in order to have a common language for communication. This will improve the (users) participation by providing a common language between different stakeholders: developers, customers, managers, etc..., but also a language between the users and the system.
- as a design technique to represent organizational knowledge and ultimately to create an organizational memory information system, in order to have a common learning artifact for the different stakeholders involved in the whole life cycle of system development and its embedding in the organization.

The whole environment (organization, human practices and system) perspectives where the system is embedded does not exist physically but is represented by means of the ontological framework OFCP at the cognitive level. Organizational, human and operational cooperation ontologies describe the cooperation according to their respectively stakeholders perspectives. We believe that the cooperation's understandings and needs are quite distinct from the different perspectives (organization, human and system).

Learning in the system development is based on artifacts such as documents types (Scenarios, Glossaries, Prototypes, etc.) (Floyd, Züllighoven, Budder, Slawik, 1992). OFCP helps to better structure such documents and to understand the semantic of their contents. In addition to the system specification level, OFCP provides an understanding level for informing the different cooperation "meanings" according to the different stakeholders and their individual needs.

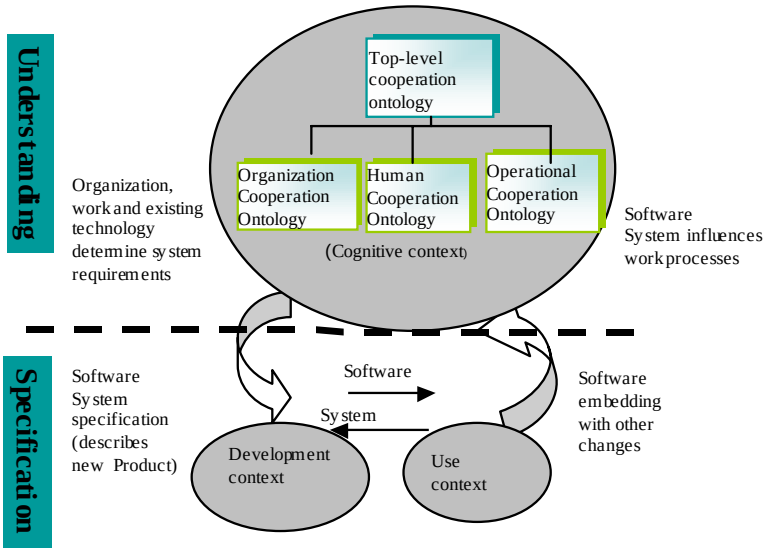

Figure 1. Ontological Framework as a Communication and Learning Artifact

In this way, OFCP extends the system development life cycle (actually limited to the specification level) to include explicitly also the organizational evolution life cycle (at the understanding level). Indeed, the relation between use and development contexts (at the specification level) describes system prototyping cycles whereas OFCP (at the understanding level) extends the whole life cycle including thus also organizational changes cycles.

Construction of the Ontological Framework

OFCO consists in a top-level ontology and three cooperation foundational ontologies (according to the definition of Guarino in (Guarino, 2006). Three knowledge areas are defined at the top-level: *active* entities, *passive* entities and *actions* which are in agreement with the principles of FRISCO framework (Falkenberg et al., 1998) supporting a constructivist view of system development approach.

An active entity is any kind of entity which is able to carry out actions (human and non-human entities) such as workers, doctors, organizational-units, teams, software agents, etc.

A *passive entity* is a special entity which is involved in a post-state of an action. It is created, modified, or only accessed for information purposes such as a document.

Action is defined by the behavior of active entities in order to change the world around them individually or together through cooperation with others, such as buy, sell, etc.

A typical cooperation scenario is when an active entity carries out an action in order to change (consult) a passive entity. Cooperation forms are made explicit at the three levels of active (communication aspect) and passive entities (collaboration aspect) as well as at actions (coordination aspect). Indeed, action could be further carried out by another active entity, passive entity could be retransmitted to another active entity and active entity could communicate with another active entity.

All entities could be organized through aggregation, classification, generalization, association and versioning dimensions.

Cooperation foundational ontologies allow the categorization of the different understandings underlying the cooperation according to organizational, human and system perspectives. They are concreter than the top-level ontology (see Figure 2) but are still application domain-independent.

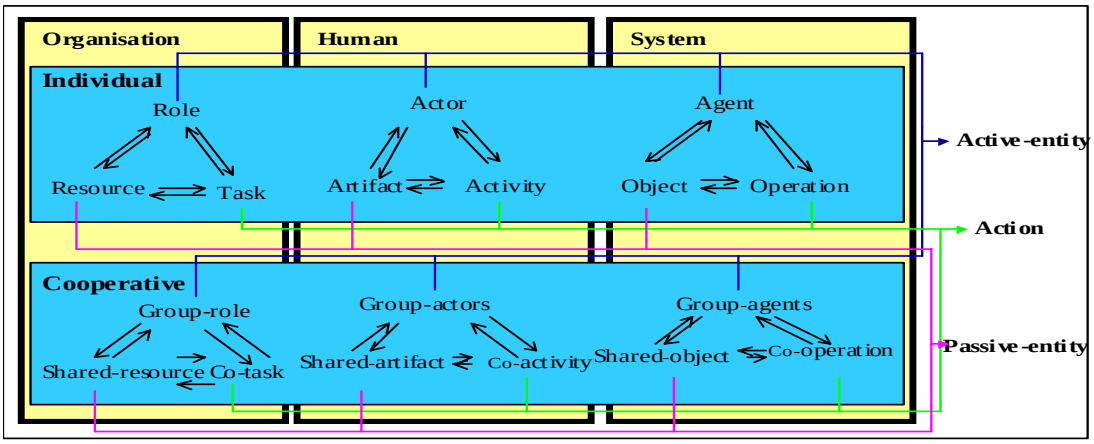

Figure 2. Ontological Framework for Cooperative Processes Meta-Models

The Figure 2 highlights the central role of human activity to relate organization goals to their operationalizations. It is claimed that relating information system to organization is achieved by relating precisely the triangles relating together active entities, actions and passive entities from the different perspectives.

The coordination between the different types of actions is controlled through the semantic link between (organizational) **task**, (human) **activity** and (system) **operation** (Floyd, 1992). Indeed, the task is the way to fulfill an organizational (business) goal. It is achieved through a set of activities which are finally executed through operations.

Activity is here central for relating organizational goals and their operationalization in the system bringing out thus the central role of humans in using the technology for achieving organizational goals. System perspective represents only computerized aspects whereas human and organizational perspectives include also the aspects not amenable to computerization. In an analogical way to consider the types of actions according to the three perspectives, we consider also that the concept of **role** (as an active entity from organizational perspective) corresponds to **actor** (from human perspective) and to **agent** (from system perspective) concepts. In the same way, **resource** concept denotes a passive entity from organizational perspective, which corresponds to **artifact** from human perspective and to **object** from the system perspective. The different entities are also classified with regards to whether they are individual or cooperative.

The used concepts serve as keywords terminology that captures the nature of the desired knowledge about the cooperation. Manifold stakeholders find the appropriate terminology to their contexts and situations. The level of accessing the knowledge and its visibility depends on which perspective (organizational, work and system), on the level of detail of the cooperation (meta-level, intensional or extensional) and on the cooperation aspect (coordination, coordination or collaboration). Each user will be able then to “zoom” into the part corresponding to his (her) focus in the framework. This will provide more flexibility for the cooperation analysis process. Indeed, the chosen basic concepts in the ontological framework allow characterizing a cooperative process in terms of network of dependencies among entities annoted through those concepts. Since OFCP should be useful at the starting point of the analysis activity in the process of system development, it should be able to begin the process from any type of entity (task-oriented, object-oriented, actor-oriented, resource-oriented, etc.).

Conclusion

In order to test the maturity of the approach, its applicability, and the effectiveness of OFCP, we are applying it to a previous hospital research project done by our research group (Krabbel, A., Ratuski, S., Wetzel, I., 1996; Wetzel, 2000)) dealing with the same research question but delivering different solutions when adopting another approach for cooperation modeling. We are editing the ontological framework OFCP by using Protégé-2000 (a frame based system and ontology editor). A preliminary representation has shown that more cooperation forms are now easily visible which were completely invisible or hard to visualize with the cooperation pictures (Wetzel, 2000) already proposed in this project. We have to study the reasons for the uselessness of the old project in the hospital actually. One condition of the maturity of our OFCP is that it should admit the solutions from the old hospital project (as

existing technical knowledge in system perspective) and be able to generate alternatives in order to extend its life cycle.

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