Semantic Group Support System for Context Adaptive Collaboration

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ABSTRACT
Collaboration is a social and interactive process, where participants join efforts toward a group goal. A Group Support System (GSS) can improve the productivity of collaborative work by structuring activities and improving communication. By using context-based adaptive techniques, a GSS can support facilitation of the participants by offering appropriate tools for a certain activity in a specific context.

In this paper we present ongoing research about a supporting framework for a semantic GSS that supports efficient collaborative work. Drawing on Collaboration Engineering, the paper explores the use of an ontology to capture and share process information that define the collaboration context.

As a result, we present an approach of a collaboration ontology that subdivides the collaboration context into the individual context of a participant and the collaborative context of a group. Researchers can use the ontology to develop context-based adaptive techniques that support collaborative work using GSS.

Author Keywords
Collaborative Work, Group Support System, Collaboration Engineering, thinkLet, thinXel, Ontology, Context-Adaptive Interaction,

ACM Classification Keywords
H.5.3 Group and Organization Interfaces: Computer-supported cooperative work, Theory and models, Web-based interaction

INTRODUCTION
Collaboration is defined as the process of a group where participants work together to achieve a shared goal [10]. A technical support for collaborative work is a Group Support System (GSS), a meeting environment based on information technology. A GSS offers a variety of local and web-based tools that link a group via computers across geographical distances and assists them in structuring activities and improving communication [9].

Unfortunately, the use of a GSS will not automatically lead to high-quality results. The GSS technology can be adapted in different ways to implement collaborative work. This adaption can lead to a high conceptual load, i.e. practitioners find it difficult to understand how GSS technology can be used to support a collaboration process [3]. As well, research has shown that collaboration is affected by the characteristics of the group; the task; the context; and the technology used [4, 9]. The resulting behavior of the group can lead to different effects that influence the efficiency of collaborative work. By using context-based adaptive techniques, a GSS could manage these effects by offering appropriate tools for a certain effect.

In our research, we analyse the potential benefits of a web-based GSS for collaboration that adapts the technology automatically to a designed collaboration process. Our purpose is to reduce the experience needed for design and execution of collaboration work using GSS. In earlier research publications, we presented a prototype of a generic GSS that uses a logical model for collaboration to design a collaboration process in a machine-readable process description [6]. The logical model can be used to provide automatically a webpage as an interface that implements the intended activity of a participant.

In this workshop paper we explore the use of an ontology in collaboration process design; to capture and share process information that define the collaboration context. We believe that an ontology-based GSS can provide better context-based adaptive techniques that support collaborative work.

2. STATE OF THE ART
In earlier work, we analyzed the applicability of the Collaboration Engineering (CE) approach to design a

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logical process description for collaborative work. Briggs et al. [3] introduce Collaboration Engineering as an approach to design collaborative work practices for recurring high-value tasks that can be executed by practitioners without ongoing support from professional facilitators. Based on the concept of a design pattern introduced by Alexander [1], CE classifies collaboration work into key patterns of collaboration and introduces design patterns for best facilitation practice, called thinkLets [3]. A thinkLet is a named, scripted and reusable collaborative activity for creating a known pattern of collaboration among people working together toward a goal [2].

We used a thinkLet as a logical design element which includes rules for the participant to achieve a collaboration pattern. We adopted the design pattern approach for reusable instruction elements, called thinXels, which defines atomic activities of a participant (like add, select and move). A thinXel is an atomic facilitator instruction leading to a response of the participants that has a well-defined function in the context of the group goal [8]. By using the concepts thinkLet and thinXel, we defined a logical model for collaboration, called Group Process Modeling Language (GPML) [7], which illustrates process information and describes their influence on the collaborative work.

A web-based GSS prototype uses the logical model to provide functionalities for design, execution and data management of a collaboration process [6]. We use the extensible markup language (XML) to describe the logical design of a collaboration process in machine-readable description. A predefined collaborative process based on the XML syntax can be uploaded and stored by the prototype as a process template. A practitioner can adapt the process template to a given group setting by a provided configuration module. To cope with the factors that influence collaboration work, we implemented a module to monitor the activities of the participants during the execution of a collaborative process. A practitioner can use this module to intervene directly in a process in connection to the active activities of each participant.

Our experience shows that the GSS prototype allows the execution of different kinds of collaborative processes. The prototype guides the participants automatically through a defined sequence of thinkLet and thinXel. According to the type of a thinXel, the prototype provides a webpage template as a user interface and adapts its facilitation instruction to the given collaboration task.

However, the prototype does not reduce the mental effort required to understand and work with the technology. A practitioner still requires knowledge about collaboration to design and adapt a logical model of a collaboration process. The prototype provides no adaptive technologies to automatically identify effects that influence collaborative work and intervene directly in the process. The used XML approach defines a collaboration process in a formal description but make no statement about the relations between the elements of a collaboration process. As a result, the prototype provides no functionality to capture and share knowledge in connection with the semantic relation of a collaboration process. In our opinion this knowledge is necessary to design context-based adaptive technologies that support collaborative work.

To reach our purpose, reducing the experience needed for design and execution of collaboration work using GSS, an ontology is the perfect basis to capture and share knowledge about collaboration. By definition, an ontology is an explicit formal specification of the terms and relations between them in a domain of interest [5]. By building a common vocabulary for collaboration work, and defining relations and dependencies between them, we enable knowledge exchange between people or software agents. Researchers can use this knowledge about collaboration to develop context-adaptive techniques that support collaborative work using GSS.

In the next section we will present ongoing research to develop a collaboration ontology. In this context, we will discuss how the collaboration context can be defined and how a GSS can use a collaboration ontology to support collaborative work.

3. AN ONTOLOGY APPROACH

According to Terveen [10], we define collaboration work as the process of a group where participants work together in a given context to achieve a shared goal. The efficiency of the collaboration is influenced by different effects (like social loafing, production blocking or synergy effects), which are related to the participants, the task or the context. The intention behind a collaboration ontology is to collect and share knowledge about collaboration between people and software agents. This collected knowledge can then be used to enhance the design, adaption and execution of the collaborative process and therefore lead to more successful collaboration work.

We see two potential user groups of such a collaboration ontology. First, there is a group of people who design, adapt and execute collaboration processes. Thereby, they use the provided knowledge about theories on collaboration and resulting factors that affect the outcome of a collaboration process. Second, there is a group of users who needs the ontology to develop different applications that use or based on the provided knowledge. Examples for these applications are context-based adaptive techniques for a GSS, a tool for designing a collaboration process or a tool that converts a designed process into a handout version for facilitation.

Given the potential of CE, our design approach for a collaboration ontology uses the existing methods and concepts of CE and the GPML. The resulting ontology consists of two ontologies: One called collaboration ontology (co) that describes the external point of view on collaboration of a client, and another one called

collaboration process ontology (cpo) that comprises structural information about the collaboration process in a pattern paradigm. We think that context-adaptive interaction for collaboration will benefit even more from the structural information. As a result, this paper takes only an abstract look at the collaboration process ontology (see Figure 1) and discusses how collaboration context can be defined. The concepts of the ontology are defined by the conceptual dictionary in Table 1. Please note that in the following subsection names of concepts are capitalized.

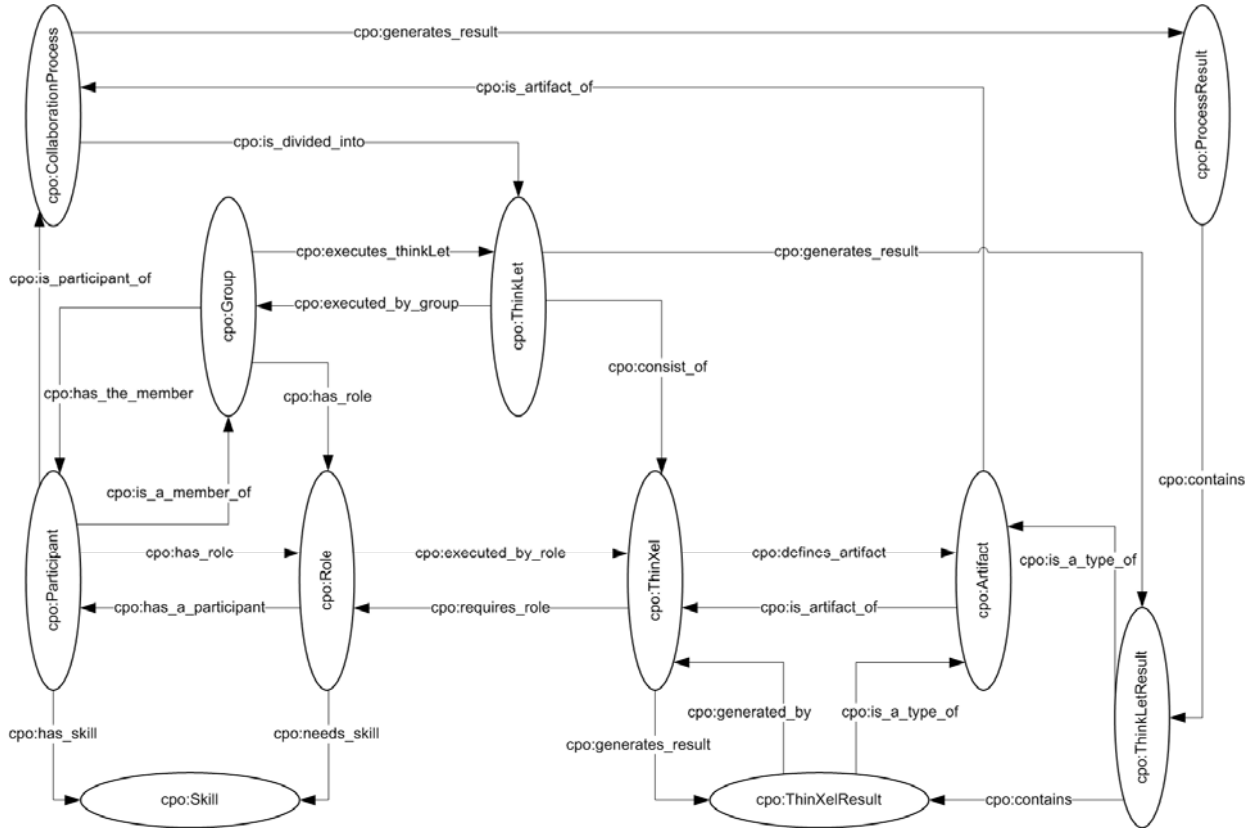

Figure 1. Extract from the Graphical Representation of the Collaboration Ontology (cpo).

4. A COLLABORATION PROCESS ONTOLOGY

The collaboration process ontology uses a pattern design approach to describe collaboration work. The concept *CollaborationProcess* denotes a process description divided into collaboration patterns. According to the GPML, a collaboration pattern is described by the concepts ThinkLet and ThinXel. A ThinkLet uses the concept ThinXel to describe the collaboration process of a Group by individual sequences of collaborative activities for each Participant of the Group. The ontology defines the concept Participant as a human being taking part in a collaboration process. A Participant has certain Skills that can be a prerequisite of a Role in a collaboration process. The concept Role is used by the concept ThinXel and denotes abstractly a set of behaviors, rights and obligations which are needed to execute a collaborative activity. Participants can be assigned to a Group for the execution of a ThinkLet.

I our opinion, context is defined as the information that characterizes a predefined or existing situation in the collaboration process. This situation can be characterized by the relations between the concepts of the ontology. By definition, a relation is an essential directional connection between two concepts that describe the relationships among them. By using the collaboration ontology, the collaboration context can be distinguished between the context of a Participant and the context of a Group.

The context of a Participant is related to a ThinXel, which requires a predefined situation so its intended collaborative activity can be executed. The ontology provides knowledge about this situation by the relationships between the concepts Participant, Skill, Role, ThinXel and Artifact. A Participant defines a person by its properties (i.e. name, address or interests). The concept Skill by itself defines the abilities a person can have in collaboration work (i.e. special knowledge, experience with a technology or soft

skills). By relating the concepts Participant and Skill, the ontology denotes the abilities of a participating person. The concept Role defines a profile of a participant that is needed to execute a collaborative activity of a ThinXel. Role uses properties like behaviors, rights and obligations a person can have. In connection with the concept Skill, a Role defines the needed abilities of a participant to hold this role. Artifact denotes products consumed or produced by collaboration work (i.e. data, time, location, technology or material). The relation between Artifact and ThinXel defines the resources needed to execute a defined collaborative activity.

We developed the ontology to predefine a collaboration process. However, during the execution of a collaboration process, the existing situation can be different from the situation predefined by the ontology. As a result, the context of a certain Participant results from the difference between a predefined or existing situation. Thereby, a given context of a Participant can be described by the concepts Participant, Skill and Artifact.

Concept	Description
CollaborationProcess	Denotes a process where participants work together to achieve a shared goal
ProcessResult	Denotes the outcome of a collaboration process
ThinkLet	Denotes a design pattern for creating a pattern of collaboration
ThinkLetResult	Denotes the outcome of a design pattern
ThinXel	Denotes a collaborative activity of a participant with a certain role under use of artifacts
ThinXelResult	Denotes the outcome of a collaborative activity
Artifact	Denotes a resource used or produced in the collaboration process
Participant	Denotes a person that participates in a collaboration process
Skill	Denotes an ability of a certain level
Role	Denotes a set of behaviors, rights and obligations
Group	Denotes some participants that work together

Table 1. Extract from the Conceptual Dictionary of the Collaboration Process Ontology (cpo)

The context of a Group needs to map the relations between the participants of a Group. This is defined by the relation between the concepts Participant, Skill, Role, Group and ThinkLet. The ontology defines the individual motivation of a participant by the properties of the concept Participant. These properties denote the individual goal of a participant or the relationship between the participants. According to small group research, we think that the relationship between the participants can be used to define specific pattern which can lead to a group behavior which influences the efficiency of collaboration work. Group denotes some participants working together to achieve a shared group goal. A statement about the commitment of a Participant for a collaboration process can be given by comparing the individual goal with the group goal. By relating the concepts Group and ThinkLet, the ontology defines the needed participants to execute a defined sequence of collaborative activities. In this context, the concepts Role and Skill define a profile of participant that is part of a Group.

With the presented ontology we have introduced an application independent approach to represent knowledge about collaboration. The ontological representation allows us to define semantic relations between the different entities that are part of a collaboration process and therefore to define the context of such collaboration work. We think that this semantic information allows us to enhance the GSS with more adaptive and context dependent interaction support.

5. A SEMANTIC GROUP SUPPORT SYSTEM

In earlier work, we introduced a GSS that uses a logical model for collaboration to implement different kinds of collaborative processes. To support the design and execution of collaboration work using GSS, we propose to reduce the mental effort required to understand and work with GSS. One approach is to use semantic knowledge about collaboration to develop context-adaptive techniques that support collaborative work. An ontology approach is the most suitable technique to capture and share this knowledge.

We think that OWL (the Web Ontology Language) would be an appropriate modeling language to represent the collaborative ontology in a formal language that can be used by a GSS. It enables an exact description of information and relationships between information. As a W3C recommendation OWL is seen as standard language for the implementation of the Semantic Web.

We call a GSS that use an ontology a semantic GSS. We think that by using the presented collaboration ontology a semantic GSS can support collaboration in different way.

First, the collaboration ontology can be used to predefine the workflow of collaboration in an intended context. A semantic GSS could use this process description to guide the participants automatically through this process. Here, the information about the process can be used to provide a webpage that allows the participant to execute the intended activities. If the collaborative process is not designed for a given group, the semantic GSS could use the defined context information (like the skill of the participants) to suggest a participant for participation. As a consequence,

the GSS could also suggest a collaborative process for a given group.

Second, to cope with the factors that influence a collaborative process, the semantic GSS need to identify the context that lead to these effects. The collaboration ontology could be used to capture context information during the collaborative work. This information could be compared with the intended context of a process. The detected deviations can be used to calculate the probability for social phenomena. A semantic GSS could provide different modules (like chat, facilitation instructions and statistic) which can be switched on and off during collaboration. By calculating the probability for a specific social phenomenon, the GSS could switch on or off a predefined module as intervention.

Third, the collaboration ontology can be used to analyze the behavior of a participant for different processes. The collected data can be used to identify preferred techniques of the participant. A semantic GSS could provide this information to the person who designs the process and defines a specific workflow for this participant. If the group uses a predefined process with a common workflow, the semantic GSS could use the collected participant information to change the order or the activities and provide the preferred activities first.

6. CONCLUSION

The next steps are to implement and integrate the ontology in a GSS and collect real world data. Based on this data, we want to learn relations between thinkLets and thinXels and the needed resources and people. Based on these learned relations, we then want to recommend collaboration tasks fulfilling certain conditions. For instance, an inexperienced user, who wants to create a new collaboration process only has to enter the goal and the resources available and the GSS automatically computes the needed collaboration steps, the thinkLets and thinXel.

Also the recommendation of similar collaboration steps using other resource can be done based on the collected data. For instance, a user who already conducted some collaboration processes with the GSS notices that at a given time some resources are missing but needed for the collaboration process. Therefore, the GSS retrieves a list of tasks that lead to the same goal and match the given available resources and present it to the user who can choose the most suitable one and complete his collaboration process.

We appeal to other researchers to take part in evaluating, using, and enhancing our proposed collaboration ontology.

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