Enhancing Collaboration Services with Business Context Models

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Abstract. In this paper we refine an organizational model to describe the execution of business activities. The model offers a *dynamic*, *actor--centered*, *context--based* and *business process oriented* perspective of the organization that explicitly addresses *information*, *cooperation* and *collaboration* needs derived from human multi--tasking capabilities. This modeling approach aims to facilitate the design of collaboration services capable of providing a more appropriate support for groups of interacting individuals. We illustrate our model with an example from an on--going case study, which was elaborated applying speech act theory to case study observations.

Keywords: collaboration, context, business process, human multi--tasking, organizational modelling

1. Introduction and Motivation

Professional, service and administrative areas of the organization involve the execution of semi--structured and ad--hoc activities. Technological support for cooperation and collaboration in these business activities is provided by a variety of groupware applications (commonly called collaboration services) such as e--mail, chat, discussion boards and file sharing systems. All these systems offer a partial support to human business actors. Designing an appropriate technological support for groups of interacting people is not trivial (Slagter 2004).

First, the required *task--technology fit* (Zigurs and Buckland 1998) means to achieve a complicated and delicate balance between providing a sufficiently rich support and avoiding information overload. Workers' information needs depend on *action contexts* defined by *personal*, *role*, *task* and *time* factors (Zacarias et al. 2005). Current work dynamics forces human business actors to frequently "switch" among several action contexts. Human multi--tasking capabilities and limitations are studied by Experimental Psychology (Rubinstein, Meyer and Evans 2001). Several cognitive theories claim the existence of mental executive processes that supervise and manage the execution of tasks. An analogy of executive processes with multi--tasking operating systems is established in (Kieras et al. 2000). Improving the task--technology fit entails devising collaboration services that provide an *integral, personalized* and *timely* information support to human business actors. This kind of support requires (1) determining action context specific needs and (2) a better understanding of action context--changing patterns.

Second, the *social technical--gap*, i.e. the gap between social requirements and what technology is able to support, is considered one of the fundamentals challenge of computer supported cooperative work research (Ackerman 2000). Interactions among human actors involved in the execution of business activities create social contexts reflecting the knowledge shared by these interacting actors. These *business contexts* include knowledge about current "state of affairs" i.e., current state of activity, participating actors and objects. Business context behavior is determined by shared assumptions, expectations, habits, protocols and rules, which support and regulate interactions among actors. Social contexts are dynamic constructs with different behavior among instances of organizational settings, activities and participants (Dourish 2004). Groupware social--technical gap can be reduced with the provision of context models enabling "context--informed" collaboration services that act according to the specific knowledge and behavior of each business context.

In this paper, we refine an organizational model introduced in (Zacarias et al. 2005) to describe the execution of business activities. This model, which offers a *dynamic, actor--centered, context--based* and *business process oriented* perspective of the organization, explicitly addresses *information*, *cooperation* and *collaboration* needs derived from human multi--tasking capabilities. The model seeks to facilitate: (1) improvement of task--technology fit, (2) reduction of social--technical gap and (3) balance between individual and group needs, when designing collaboration services. Moreover, since groupware often fails for lack of an explicit task control (Houben 1998), explicit business context models provide a means for supporting the execution of ad--hoc activities. The remaining of this paper is structured as follows: section 2 reviews related work on context and speech--act theory. Section 3 refines our model. Section 4 illustrates our model with an example from an on--going case study. The example was elaborated applying speech act theory to case study observations. Section 5 offers our conclusions and future directions.

2. Related Work

This section presents work supporting our concepts and modeling approach. Section 2.1 contrasts the engineering and sociological approaches to context and briefly discusses two context--based organizational models. Section 2.2 summarizes Speech Act Theory concepts.

2.1. The notions of Context

Although the notion of context plays an important role in multiple disciplines, there is no standard concept or theory. This notion varies according its area of application. However, there is consensus around one single idea: its relational nature i.e., context is always related to something else.

Classical Engineering Approach: In engineering, context has been approached as a stable and discrete notion. Context is viewed a collection of things (sentences, propositions, assumptions, properties, procedures, rules, facts, concepts, constraints, sentences, etc) associated to situations (environment, domain, task, agents, interactions, conversations, etc). This notion is reflected by the "box metaphor" (Benerecetti, Bouquet and Ghidini 2001). The intuition is that context is a "box" where its content depends on a set of parameters. The specific parameter set varies according to the area of application. In Artificial Intelligence, parameters (called dimensions) such as time, location, culture, topic, granularity and modality have been proposed as defining elements of context (Lenat). Context--aware applications identify localization, user identity, activity and time as context parameters (Dey 1999). A proposal for a workflow context in Maus (2001) includes the following parameters: function, behavior, causality, organization, information, operation and history.

Sociological Approaches: Seeking to improve system sensitivity to specific settings, research in context--aware computing is focusing on a view of context inspired by sociological investigations of real--world practice (Dourish 2004). This work contrasts the objective account of engineering and the subjective account of phenomenology and discusses the implications of approaching context from the latter perspective. The phenomenological perspective argues that (1) context is a relational property among objects, (2) the scope of contextual features are defined dynamically, (2) context is relevant to particular settings, instances of action and participants and (4) context and activity are not separable i.e. context is embedded in activity and arises from it. Under this perspective, the focus moves from context representation to context support.

The apparent contradiction between the objective and subjective positions is denied by Structuration Theory (Giddens 1984), which seeks a balance between both positions. According to this theory, interactions among subjects both produce and reproduce social practices. On one side, social practices are produced from interactions among subjects. On the other side, from these interactions emerges an objective structure (interaction context) which provides rules and resources that simultaneously support the reproduction of social practices and constrain subject interactions.

Context Use in Organizational Models: Distributed knowledge management projects (Bonifacio and Bouquet 2002) recognize the subjective, social, and nature of knowledge, and approach organizations as a network of contexts. These projects are developing theoretical frameworks and technical solutions under this organizational perspective. A context--based approach of organizations is also proposed in (Gachet and Brézillon 2005). This work makes a case for the need of making explicit several kinds of organizational contexts. Although context--based, these approaches are not business process--oriented and do not address human context changing dynamics.

2.2. Speech Act Theory

Developed by Austin (1975) and extended by Searle (1968), speech act theory focuses on the use of language to *modify* states of affairs, rather than to *describe* states of affairs. Austin claimed the existence of sentence that were in themselves actions and called them *performatives*. Performatives express a speaker's intention with his hearer. Performatives are not true or false, they succeed or fail. Performatives succeed if they satisfy a set of social conventions called by Austin as *felicity conditions*. The action involved in a performative is a *speech act*. Thus, *performatives* are *speech acts* subject to *felicity conditions.* According to Austin a speech act is composed of three kinds of acts: the *locutionary act* is the act of uttering the words, the *illocutionary act* reflects the speech act intended effects and the *perlocutionary act* reflects the speech act actual effects. Perlocutionary acts are less frequently tied to verbal expressions Searle does not distinguish among the locutionary and the illocutionary acts. Rather, he describes speech acts in terms of a *propositional content* and its *illocutionary force*, which expresses the speaker's intention. The propositional content is a dimension of the illocutionary act. Since its origins, speech act theory has been applied in several areas such as discourse analysis, message structuring and categorization, agent communication language design and organizational modeling .

3. Modeling Business Contexts

We start this section defining *business contexts* in terms of three overlapped, but still different, concepts: *activity, action* and *interaction contexts*. Later we use these concepts in refining our model.

3.1. Defining Business Contexts

Contexts are used in several areas. The context notion of engineering has been mainly used for automation purposes, i.e. enhancing automated actors or reasoning mechanisms. Nevertheless, when aiming at supporting human actors, social sciences offer a more appropriate approach to context.

Table 1. Action Context parameters and Contents

Parameters	
Task	Part of business activities, which in turn are part of business processes. Tasks are described with a predicate (verb and complements). The task parameter defines formal behavior and information needs
Role	Capabilities used by an actor in executing a specific task. Although also described with a verb and its complements, tasks and roles are different. The role parameter defines other kind of formal information needs.
Individual	Human actor executing a task. Individual are described with proper nouns. The individual parameter defines preferences and habits such as preferred locations, tools or methods, and informal information needs.
Time	Specific moments or time intervals, defines time--related information relevance
Contents	
Behavior	Relevant set of actions and interactions relevant for an action context. Action and interactions are the atomic units of behavior of our model. Can be formal (pre--defined by task or roles) or informal (not--predefined)
Action	Described with a verb and its complements. The verb describes a specific act, the direct complement describes an information item used or produced in that act. Circunstancial complements describe action--related preferences or habits.
Interactions	Their description is more complex. We describe them using speech act theory. Verbs are also an important identifier of interactions. Whilst some verbs are related to actions, others are related to interactions.
Information needs	*Formal* and *informal information items* used, produced and shared in action context actions and interactions.
Information items	Can be *formal* or *informal*. Formal information items are embedded in documents and files of different kinds. Informal items are ideas, facts, meanings, questions, answers, point of views and so on, used in building formal information items. Embedded in messages.

The main components of action contexts are illustrated in table 1. An **action context** reflects the *actual behavior* and *information needs of a* human actor when he performs a specific *task* under a given *role.* Since these needs change in time, an *action context* defines an actor's *state* during some *time interval*. Such *state* represents a subset of actor's properties and their values and it is determined by his on--going *actions and interactions*. Although we here use the "box metaphor" of the engineering approach, this is not a discrete notion since we will consider several relevance degrees.

Human actors participating in a business activity act and interact from specific action contexts. These interactions are partially determined by the *activity context* i.e., *pre--defined* activity *behavior* and activity *state*. At execution time, successive interactions among *action contexts* create a collective object that we define as the **interaction context**. This definition is mostly influenced by sociological approaches to context. The interaction context reflects *actual* activity--related behavior and state of affairs. The shared part of interacting action contexts and the activity context belong to the interaction context. Thus, these concepts are somewhat overlapped. Interaction context behavior is determined by a number of elements such as interaction rules and protocols. *Interaction protocols* describe *valid sets of action and interaction sequences* among action contexts that meet specific purposes related to tasks or activities. *Interaction rules* define the *set of conditions required for successful interactions among action contexts*. Both cooperation and collaboration in business activities are supported and regulated by the specific rules and protocols of the interaction context where they take place. Figure 1 illustrates the interaction context main components.

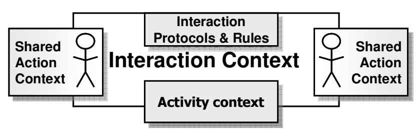

Fig 1. Interaction Components main components

In summary, *business contexts* are approached as dynamic and composite concepts formed by the interplay of several *action contexts* mediated by an *activity* and *interaction context*. Business context particular properties and behavior will depend on the action and interaction history among participating actors. Different human actors performing identical tasks and roles behave differently. Consequently, business contexts of identical activities and role sets but with different participants, will exhibit different properties and behavior.

3.2. Modeling Organizations: an *"Operating Systems"* Metaphor

Due to their multi--tasking nature, human business actors are capable of handling several *action contexts* and participating in several *interaction contexts* .We propose a model to that explicitly addresses human context identification and management capabilities. Figure 2 illustrates our model. The organization is viewed as a network of individual and collective multi--tasking actors**.** The model explodes the actor notion and approaches it as a network of contexts managed by actor's own "operating system". Three kinds of actors are defined: *human, business process* actor and *organization* actor. *Human actors* are modeled as a network of *action contexts*. Human "operating system" determines individual habits and action context changing patterns. The *business process actor* is a collective actor modeled as a network of *activity contexts*. Its "operating system" acts as an "engine" managing the execution of pre--defined flows of work. The *organization* actor is another collective actor which represents sets of organized groups of interacting individuals with specific purposes such as teams or departments. It is modeled as a network of *interaction contexts*. The organization "operating system": (1) provides a communication environment based on shared expectations, rules and protocols which support and regulate activity--related actions and interactions and (2) manages ad--hoc behavior and exceptions not handled by business processes. The inclusion of two kinds of collective actors explicitly acknowledges the organization's capability to act flexibly by combining pre--defined and structured behavior with ad--hoc behavior. It also acknowledges that *operational procedures* handled by business processes, are ultimately modified by individual features and *social practices* of the human actors involved in its execution.

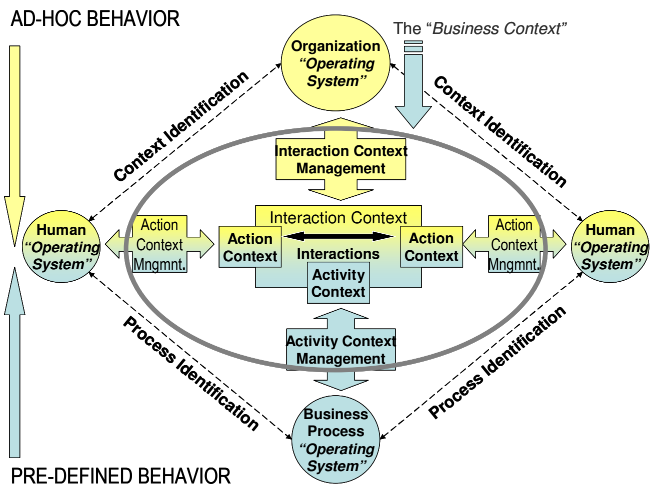

Fig 2. The proposed model based on the Operating Systems Metaphor

We use the ***operating systems*** metaphor for several reasons. First, it provides a conceptual framework with a clear cut separation between actual execution and its management. Second, it allows a dynamic view of actors. Third, it offers a straightforward abstraction of human multi--tasking capabilities. In order to act or interact, human actors must first identify and activate the corresponding action context. This metaphor allows an explicit representation of context identification and management operations. From our point of view, this organizational perspective facilitates a more personalized and timely support to human business actors. Moreover, an overall view of individual and collective actors facilitates the design of services seeking a balance between individual and group needs. The model assumes a flexible business process management. However, we do not focus on business process issues. Rather, we address model context--related concepts from a *business process perspective*. In our work, we aim at building dynamic business context models from activity--related action and interaction history. Specifically, we seek to capture *particular* elements of: (1) interaction contexts, i.e. *shared action contexts* (2) human "operating systems", i.e. individual *habits* and *action context--changing patterns*, and (3) organization "operating system" i.e., supporting and regulating elements of action context interactions, such as *shared interaction rules* and *protocols.*

4. Example

In order to illustrate our model, we present an example from observations of an on--going case study, which involves a software development team of 4 programmers and their project manager. The team develops web applications for a commercial bank. Due to space limitations, we do not describe the collecting procedure in detail. Computer and non--computer based actions and interactions of the team were registered in a chronological order. This was manually done by team members and complemented by the project manager. Each action or interaction was described with separated sentence. Three weeks of actions and interactions were registered, encompassing 534 sentences.

Table 2. Applying speech act theory to interactions

time	Action/Interaction	Illocutionary act (intended effects)	Perlocutionary act (actual effects)	Actor/Sender's State	Expected Receiver's State
9:00	Ann REQUEST project control meeting at 3 pm	Get Bob, Sue to COMMIT to project control meeting	Bob, Sue COMMITTED to project control meeting (10:30)	Ann EXPECT Bob, Sue to COMMIT to project' control meeting until 1h before meeting	Bob, Sue must COMMIT to meeting or REQUEST another date until 1h before meeting
10:30	Bob, Sue COMMIT to project control meeting	get Ann to KNOW Bob, Sue's commit	Ann DO project report for project control meeting (10:45)	Bob, Sue EXPECT Ann KNOW their COMMIT and send project report 1h before meeting	Ann MUST prepare meeting and send project report 1h before meeting
10:45	Ann DO project report for project control meeting			Ann INITIATE project report for project control meeting	
11:00	Bob QUESTION who's responsible for credit card application's maintenance	get Ann to ANSWER who's responsible for credit card application's maintenance	Ann QUESTION Maintenance who's responsible for mail's application maintenance (11:05)	Bob EXPECT Ann to ANSWER who's responsible for credit card application's maintenance today	Ann must KNOW who's responsible for credit card application's maintenance today
11:05	John DO develop mail application			John CONTINUE mail application	
11:05	Ann QUESTION who's responsible form credit card application's maintenance	get Maintenance to ANSWER who's responsible for credit card application's maintenance	Maintenance INFORM that only Dpt.'s chief KNOW who's responsible for credit card application maintenance (11:30)	Ann EXPECT Maintenance to ANSWER who's responsible for credit card application's maintenance today	Maintenance may ANSWER who's responsible for credit card application's maintenance today
11:10	Ann DO project report for project control meeting			Ann CONTINUE project report for project control meeting	
11:30	Maintenance INFORM that only Maintenance Chief KNOW who's responsible for credit card application maintenance	Get Ann to KNOW that only Maintenance Chief knows who's responsible for credit card application maintenance		Maintenance EXPECT Ann to call Maintenance chief	Ann KNOW she must call maintenance chief today

Table 1 illustrates some structured actions and interactions, based on Searle's approach. We distinguished among illocutionary and perlocutionary acts. The latter were determined establishing cause--effect relationships among related actions and interactions. We identified illocutionary force (in uppercase) and propositional content of illocutionary acts. We used the terms sender--receiver, rather than speaker--hearer since several interactions were computer--mediated. By appropriately grouping actor actions and interactions, we may discover actual roles, tasks and activities. This grouping is illustrated in table 3 for actor Ann. We inferred the *manage project* role from the following actions and interactions: (1) *request* project control meeting, (2) *do* prepare project report status and (3) *answer* application related information. Also, two Ann's tasks were identified: (1) *control team software projects* and (2) *provide application--related information*. The identification of tasks and roles required analyzing illocutionary force and propositional content of illocutionary acts.

Table 3. Identifying human actors and their roles, tasks and activities

Human actors	Roles	Tasks
Ann	Manage Projects 1) REQUEST project control meeting 2) DO PREPARE project status report 3) ANSWER who's responsible for…	1.Prepare project control meetings a-- REQUEST project control meeting b-- DO PREPARE project status report 2. Provide application related info a-- ANSWER who's responsible for…

Table 2 also shows. how illocutionary and perlocutionary acts change Sender's and Receiver's states. These states describe actors' information and collaboration needs. This enables to identify actors' different action contexts and their evolution in time. Table 4 shows the evolution of two action contexts: (1) Ann executing task *prepare control meeting* under the role of *manage projects* between *9 and 14:00* and *(2) Ann* executing task *provide application--related information* (under the same role) *between 11 and 14:00.*

Table 4. Ann's action contexts

Human actor	Role	Task	Time	State
(1) Ann	Manage Projects	Prepare project control meeting	9:00----10:30	~~EXPECT Bob, Sue to COMMIT to projects' control meeting until 1h before meeting~~
			10:30----14:00	MUST prepare meeting and send project status report
(2) Ann	Manage Projects	Provide application----related info	11----11:30	Ann must KNOW who's responsible for credit card application maintenance
			11:30------------	Ann must ASK Chief Maintenance who's responsible for credit card app. maintenance

To appropriately identify human and organization "operating system" elements, more complex analysis techniques are required. In table 5 we show some basic elements of a human (5a) and business context (5b) operating systems identified in table 2 and complemented by Ann. In this example we are not showing any interaction rule.

Table 5. "*Operating System*" Elements

a.---- Human Operating System (Ann)	b.---- Organization Operating System (team)
Habit: Ann sends project status report 1h before the meeting **Action Context----switching rule 1**: Ann interrupts other tasks to provide application----related information, because this task is shorter (complemented by Ann) **Action Context switching rule 2**: When free, call Chief Maintenance	Team Project control meeting protocol: (1) Ann REQUEST meeting (2) Team ACCEPT or REQUEST another data (3) Ann SEND project report 1h BEFORE meeting (4) Team READ project report BEFORE meeting

Whilst modeling action contexts (table 4) enables to support actors' specific execution needs, capturing human "operating systems" allows helping actors to manage his several tasks (table 5a). Collaboration services based on the organization's particular interaction rules and protocols (organization operating system ---- table 5b) would provide a more appropriate support to group interactions.

5. Conclusions and Future Work

In this paper we refine a *dynamic*, *actor----centered*, *context----based* and *business process oriented* modeling approach to describe the execution of business activities introduced in (Zacarias et al. 2005). *Business contexts* are defined as the interplay of three kinds of context: *activity*, *action* and *interaction contexts*. The model uses an *operating systems* metaphor to address information, cooperation and collaboration needs taking into account human multi----tasking capabilities. We illustrate our model with an example elaborated using a speech act----based analysis of action and interaction logs of an----going case study. This method offers several benefits. It eases log analysis as it makes explicit shared information and collaboration needs of human actors. It also provides a common format and it will enable to decompose interactions into machine----understandable elements.

The overall goals of our research are: (1) provide an organizational view to facilitate the design of "context informed" services that improve task----technology fit, reduce socio----technical gap and balance individual and group information and collaboration needs, (2) provide groupware with means for supporting the execution of ad----hoc activities and (3) provide a bottom up approach for the specification of tasks and roles.

Our work is in a preliminary stage. At this present moment we are focusing on defining ways to describe and represent business contexts. Manual analyses pose several limitations. Automated support for log storage and analysis must be developed. Analyzing actions and interactions with speech act theory enables the retrieval of contextual knowledge, but it does not convey valuable tacit knowledge. Observation and collection procedures must be enhanced with techniques to elicit this knowledge. Specifically, ethnographic methods will be explored. We aim at creating dynamic business context models from action and interaction logs. This will require further structuring the logs and researching on appropriate analysis and modeling techniques. Model validation methods must also be devised. Additional case studies are required to further test, adjust and refine our model as well as our observation and collection procedures.

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