Cooperation Technology - TDT4245
A summary

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Abstract

Summary of Cooperation Technology.
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Known lacks are: Concrete approaches; Managing task interdependencies and workspace awareness, Group calendar systems ...

Contents

1 Terms and definitions

CSCW Computer Supported Cooperative Work. A research area for the concept of systems supporting cooperative work. Technology that support this are called groupware and can be seen as instantiation of the CSCW concept.

F2F - Face2Face Form of communication that has the same affordances as traditional face-to-face communication amoung persons. Note that this can be traditional face-to-face, but can also be enabled through computer support. Extended audio/video communication is one example of this.

Media spaces Is a electronically aided environment where participants can collaborate even when they are not physically present in the *same space* and/or present at the same *time*. Example of this is a shared workspace like Sakai.

Virtual reality People *see* each other *within* the technology. Examples are Instant Messangers (MSN, IRC) and CVE's.

Augmented reality People *act through* the technology. Examples are CAVEs used for collaboration (tangible UI?) and technology that are "present in real life" (ubiquitous).

CVE - Collaborative Virtual Environments A virtual space intended primarily for collaborative work. Often in a 3D world with avatars that represents people. Second Life is one example of a virtual environments and can be seen as a collaborative setting. There are hundreds of CVE's in different categories/incentives such as; Games, learning (e-campus), general collaboration etc ... Generally CVE's try to resemble real-life in best possible way but at the same time supporting collaborative activities.

Workflow systems A system that supports workflows in the terms of modeled processes and their execution. Highly related to common BPMN[1] systems and BPM[2] in general.

2 Concepts and frameworks

2.1 Affordances of communication media

Affordances can be categorized into several categories, depending on their abilities. The categories are noe solely atomic in the sense that an element in an actual

[1] Business Process Modeling Notation
[2] Business Process Modeling/Management

technology fit into one, and one category alone. There are overlaps within the categories. Proposed categories from ???? are:

Audibility Participants hear other people and sounds in the environment

Visibility Participants can see people and objects in the environment

Tangibility Participants can touch/feel people and objects in the environment.

Co-presence Participants are mutually aware that they share a physical environment. The term physical can be interpreted as a virtual environment in some contexts.

Mobility Participants can move around in a shared environment.

Cotemporality Participants are present at the same time.

Simultaneity Participants can send and receive messages at the same time. With messages being all forms of communication.

Sequentiality Participants take turns. One turns relevancy to another is signaled by adjacency.

Reviewability Messages do not fade over time and can be reviewed.

Revisability Messages can be revised before being sent.

The idea is to categorize elements in a technology so that one can analyse the different affordances achieved by the different elements. As mentioned, the categorization is fairly subjective in practice and can require som loosening to adapt in a real life use.

2.2 Awareness

2.2.1 Situation awareness

One concept of awareness is situation awareness (SA). The characteristics of SA are; high information load, variable workload, dynamism, complexity and risk. The term SA comes, originally, from military research, one example where SA is highly important is a jet-fighter pilot.

Generally SA divides the concept of process into three levels; *perception of relevant element*, *comprehension of those elements* and *prediction of the states of those elements in the near future*. Essentially the main focus is on elements, first perceive them, then understand them and finally predict the future of them.

2.2.2 Workspace awareness (WA)

In a collaborative setting, where groupware is used to support the work, the awareness concept needs to alter slightly from the SA-concept. In general WA and SA share many concepts, separated with WA being more specialized toward concrete situation (shared interaction with a workspace). In addition, the main difference between SA and WA is that WA does not require the information load to be high - and usually it isn't.

In WA the participants needs to cover more overhead tasks than for SA. This is due to the fact that in WA there are several participants rather than for (usually) one participant in SA. Leading to the need for a collaborative task (overhead) between the participants in WA.

When the WA is established it needs to be maintained. This is done through a *perception-action cycle*, which essentially acknowledge that the *actors knowledge* greatly affects the perception, use and prediction of the elements. Modeling the WA into three main parts; environment, knowledge and exploration.

As we are focusing on WA in a groupware context, the limitations for perception are much greater than for a general context. The rational being that in groupware the environment are simplified from a real-world to a computerized environment, for example introducing great limitations on the user input (mouse, keyboard ...).

Gathering WA information and how it is gathered is essential for a system that provides WA. The information is gathered from three different sources; *people's bodies*, *artifacts in the workspace* and *conversations and gestures*. Mechanisms for gathering WA information from these sources are; *consequential communication*, *feedthrough* and *intentional communication*.

Consequential communication can be called implicit communication and is in short; A mechanism for *seeing and hearing* other people in the workspace. An example of this is when one gathers information based on other peoples actions.

Feedthrough is information *provided by artifacts* in the workspace. Artifacts in a workspace are always providing some sort of WA information. Either by just being there, making sound when changing state (moved, sorted, clipped ...), by their placement and so on. The information is gathered primarily by the actor which is using the artifact, but can also extends to other people in the workspace.

Intentional communication is explicit communication between actors in the workspace. Intentional in the sense that actors have the intention to provide awareness information to each other. This can be through conversation like:

"What are you doing? - Compiling the betaversion." Which in turns can be gathered by a third party actor and thus distributing awareness information in the workspace. Gestures are also example of intentional communication ("How big was the fish?" - showing size with hands).

An important aspect is that the actors providing the information are doing it *intentionally*.

Activities where workspace awareness is used are necessary to identify for further analysis and implementation of WA elements in a system. The activities and the coherent benefits that WA provides are listed in table 1.

2.3 Techniques for achieving WA

The framework proposed in (Gutwin and Greenberg 2002) is aimed at supporting design of groupware. In addition to pure theoretical approaches they presents a set of concrete approaches to aid the design with the intention of providing workspace awareness in the system.

First the placement and content-type of a widget is handled. It is suggested to perform an analysis of the widget with respect to two dimensions; *placement* and *presentation*. Each dimension is divided into two classes - providing a matrix such as table 2.

The different classes are attributes linked to the interface element. For placement there are two main alternatives both focusing on placement relative to the workspace environment. Either situated, which means that the widget is *inside* the workspace, or seperate, which , intuitively, means the widget is *seperate* from the workspace.

For presentation there are to classes which focus on the way the widget presents the awareness information. Either it presents it *literal* which is to present the information in the *same form as it was gathered* - meaning that no extraction or aggregation, and alike, has been performed on the information. The other class is symbolic, which is in a way orthogonal to literal in the sense that here, the gathered information has *been processed*, either by extracting concepts or aggregating the information into new information (eg. by using symbols).

The framework also presents several elements of awareness taken time into consideration. Naturally it is interesting to focus on three classes of time: *past*, *present* and *(near) future*. Given the increased complexity in dealing with prediction of future, the framework does not focus especially on this time class. When analysing and designing elements of awareness with respect to the past and present the framework introduces *a set of questions* with related elements, listed in table 3 and 4. The questions giving answers to different types of workspace awareness.

Activity	**Benefits achieved by workspace awareness**
Management of coupling	Assists people in noticing and managing transitions between individual work and shared work. Meaning that the it is easier to divide or couple the individual work and shared work activities.
Simplification of communication	Allows people to use the workspace and artifacts as conversational props. Such as use for metaphors/supporting speach, demonstrations, visual concrete evidence and so forth.
Coordination of action	Assists people in planning and executing low-level workspace actions to mesh seamlessly with others. Should be used in cooperation with the management of task interdependencies (section 3.2).
Anticipation	Allows people to predict others actions and activity at several time scales. In essence, prediction of another actors future tasks/activities. Difficult to support directly in groupware due to the non-explicit information available (need to analyze, aggregate ...).
Assistance	Assists people in understanding the context where help is to be provided. Example, if one actor needs help and others are aware of this $\Rightarrow$ easier to get/provide assistance.

Table 1: Activities and the use/benefits of workspace awareness.

		Placement	
		Situated	Seperate
Presentation	Literal		
	Symbolic		

Table 2: Matrix for presentation and placement analysis of an interface element.

Elements of workspace awareness related to the **present**		
Category	Element	Specific question
Who	Presence	Is anyone in the workspace?
	Identity	Who is participating? Who is that?
	Authorship	Who is doing that?
What	Action	What are they doing?
	Intention	What goal is the action part of? What is the goal?
	Artifact	What object are they working on?
Where	Location	Where are they working?
	Gaze	Where are they looking (seeing)?
	View	Where can they see?
	Reach	Where can they reach? (Permissions . . .)

Table 3: Elements of workspace awareness related to the **present**

In real-life situations the designer can find that the elements and questions are a bit overwhelming. The analysis is purely intended for support only and it is not a requirement to address every element/question proposed by the framework.

3 Organizational issues

3.1 Social translucence

In a physical, real-life, situation actors are able to perceive subtle hints and clues given in a social setting. Benefits obtained by this is (implicit/indirect) awareness of other actors. This is not the default case for virtual systems and needs to be concidered when designing a system for social collaboration. Social translucence is an approach aimed at supporting the design for systems to overcome this lack. Mainly, social translucence includes the issues mentioned before and provides different properties of social translucence in systems. The properties are:

Visibility Social significant information is visible and attracts attention in a natural matter, for example by replicating the real-world.

Elements of workspace awareness related to the **past**

Category	Element	Specific question
How	Action/task/event history	How did that operation happen?
	Artifact history	How did that artifact get that state?
When	Event history	When did that event occur?
Who	Presence history	Who was here and when?
Where	Location history	Where has an actor been?
What	Action history	What has a person been doing?

Table 4: Elements of workspace awareness related to the **past**

Awareness Provides information about others, what they are doing and so on. This can (un)consciously constrain the actors available actions. (glass door; if someone stands in front of it - can not open quickly).

Accountability Mutual awareness of perceived information. "I know that you know that I know you are there."

Social translucence does not necessarily aims at reflecting the real world in a one-to-one mapping. It is more geared towards providing relevant (good) social information in a natural way. Social implying; social relevant information - Translucence implying; not all socially relevant information should be made visible (selective).

Concrete approaches in providing social translucence is difficult. Approaches suggested are social proxies. Mainly modeling the real world social information in a proxy that visualize the information. For example; a circle with actors as dots - nearing the center according to how many lines of code they write.

Social translucence are complex to implement in systems, but the benefits achieved may be great. Consideration on what information that should be visible, taking "translucence" and privacy into account, must be performed. Then there is the question on visualizing the information in a natural way - which is beyond this summary's scope. Imagination with psychology aspects is one general approach.

3.1.1 Informal vs. Formal communication

Formal communication is the easiest form of communication to measure and capture in a managerial context. However, informal communication is often the most producing. Empirical research have found that informal communication stands

Formal	Informal
Scheduled in advance	Unscheduled
Arranged participants	Random participants
Preset agenda	No arranged agenda
One-way	Interactive
Impoverished content	Rich content
Formal language	Informal language
Used for predicted situations (co-ordination)	Used for unpredicted situations
Not useful fo social maintainance of the group	Useful for social maintainance
Limits creativity	Enable creativity

Table 5: Properties of formal vs. informal communication

for around 90% of all communication done. The rational is fairly easy to grasp, an informal communication is extremely more feasible in almost all aspects; start, mould in direction wanted .... Table 5 lists properties for formal vs. informal communication - it is, as for the context itself, fairly intuitive. The list should not be considered absolute - and merely as a guideline for identifying the type of communication.

It is therefore necessary, if not essential, for a groupware system to consider the communication methods provided. In a physical setting, geographical proximity is an essential factor in providing informal communication (water-cooler-talks, lunch rooms, play rooms ...). In a groupware system approaches with the aim of supporting informal communication can be; chat-systems (not logged etc.), forums, walls (facebook) and alike. The main idea is to enable a "feel-free" feeling for the participants.

Informal communication can often escalate into a context which leads to a more formal approach and the need for a formal communication. Groupware systems should take this phenomenon into consideration and provide easy ways of transformation between the two types of communication - thus exploiting the type of communication to produce measurable results.

Another aspect which emphasizes the need for informal communication is the fact that formal communication often tends to kill creativity and "free-thinking", which, in most cases, are necessary for producing a excellent result.

3.1.2 Knowledge management

In an evolving organisation the knowledge and experience captured by the involved parties are of great value. However, the knowledge often stays within the boundaries that they were captured - eg. an employer get experience in GUI-design and no one around him knows or learns from him. This is highly inefficient and can lead

to a demoralizing environment due to the lack of learning among staff. Knowledge management addresses this issue and especially tries to find approaches that will decrease the deficit transfer of knowledge. With a focus on collaborative environments, we reveal the same issues as for a general setting. One main difference may be the fact that a collaborative environment is easier adaptable to focus primarily on knowledge capturing and transfer. Approaches that has succeeded greatly is the use of wiki software and the movement of "web2.0" where users themselves creates the content.

The Wikipedia organisation (Wikipedia 2007) is one example of success, especially in the terms of providing knowledge (transfer). However, there has been little, to none, focus on who actually creates (captures) the knowledge on Wikipedia. Although the popularization of Wikipedia started to raise questions on who contributed, there has been a common understanding among research on wiki software that contributions are the main problem. In general, a rule of thumb for wiki-software is that 99% of the users are just *using* the wiki and merely 1% are contributing, and actually capturing knowledge. This raises several questions like, is the captured knowledge accurate (may be biased)?, why aren't the others sharing their knowledge?

Approaches to overcome these issues are often based on; forcing participation, promoting contributions (money, time ...) and similar. None of these approaches are very sustainable. The wiki software is primarily built with the hypothesis that contributions should be as natural to the users as just feeding of the knowledge. There are no straightforward answers to overcome the problem of knowledge management and especially the "wiki-problem" - this anecdote are merely for promoting awareness on the issues and the importance of knowledge management in an evolving organisation.

3.2 Coordination

What characterizes cooperation are elements like; multiple actors and multiple tasks. Actors involved are typically from different disciplines with their own competencies and often distributed. The work to be performed includes a set of tasks that may or may not require cooperation *between* actor disciplines. This results in an increasing complexity in performing the tasks.

Tasks that are part of such work are often, if not always, *dependant on each other*, often refered to as **interdependant tasks**. Hence, interdependant tasks can not be performed in any order, by any actor(s) or in different locations by default. This results in an highly increasing task complexity.

In an attempt to resolve the interdependencies of the tasks one need to manage the tasks in a structured way. The managerial work is coordination and is *overhead* work, in the sense that it is not contributing to the actual work - just supporting

it. The coordination of activities also increase in complexity according to the tasks under coordination. This results in an overwhelming complexity for the actors that perform coordination and leads to the need for *supporting coordination mechanisms.*

The usual approach for supporting coordination is to provide *awareness among actors.* In its simplest form awareness (2.2) can be to notify (signal) a change of state in a task to involved actors. The signal can be perceived by the actors in different ways; via senses, indirectly or directly. In other terms the support mechanism should provide a way for actors to *monitor the state of affairs of the field of work and of each other.*

These "basic" awareness techniques are, however, not always sufficient when handling complex interdependant tasks and coordination among them. Which leads to the need for more advanced *coordination mechanisms.* Proposed in (Carstensen and Schmidt 1999) is a short definition on coordination mechanisms:

> A coordinative protocol with an accompanying artifact.

Elaborating more on the concept we find that coordination mechanisms provide a *precomputation of task interdependencies*, thereby resolving issues raised by task interdependencies and their belonging complexity. More concrete the concept **reduce the space of possibilities** presented to the actor in a given situation. Introducing the concept of coordination mechanisms are by no means a silver-bullet! Coordination mechanisms are only assisting actors by providing a set *local and temporary closures.* Closures in the sense, mentioned, reduction of possibilities offered to the actor.

In addition to this, coordination mechanisms needs to be of an adaptable (*malleable*) nature. The rational being that one can not foresee all deviation or changes in the process of distributed cooperative work. Being adaptable requires the coordination mechanisms to provide **visible** *embedded flows* and *structures* to the actors. Embedded flows and structures being the elements providing workflows or precomputations of the task interdependencies.

3.3 CIS - Common Information Spaces

Common information spaces is a concept which includes artefacts that are mutually accessible for actors participating in a collaborative setting. In addition to providing a shared space of artefacts, CIS also tries to give *meaning* to the artefacts based on what actors perception of the artefact. Understanding the semantics and context attributes of an artefact are complex to fulfill perfectly. Nevertheless, attributing meaning to an artefact gives great advantages for the cooperation between actors using them.

For further understanding and analyzing a common information space, seven parameters have been introduced to characterize a CIS (Bossen 2002). The parameters are:

The degree of distribution Physical distribution of actors which can limit the coordination activities possible (email, documents, face-to-face ...)

The multiplicity of webs of signifance Actors perception of what is significant. May be different between actors, thus increasing the complexity of achieving a mutual understanding between them.

The level of required articulation work The collaborative setting/environment requires different types of coordination activities and hence leading to different levels of complexity.

The multiplicity and intensity of means of communication Required communication activities needed. May differ between each collaborative environment. Face-to-face is often considered the best method - but may not always be feasible.

The web of artefacts The needed artefacts for coordination and collaboration work.

Immaterial mechanisms of interactions The habits and organizational structures that implies what to expect in terms of interaction among actors and artefacts. For example, routines for one actor $\Rightarrow$ other actors expect this activity to happen.

The need for precision and promptness of interpretation Levels of precision needed in activities to better/easier interpret the actual meaning.

3.4 Mobility

In a collaborative setting mobility is often required or at least highly beneficial. Given that most collaborative environments have some degree of distribution enhances the need for mobility with synchronous and asynchronous work. The general term, mobility, is fairly intuitive, nevertheless, there is fairly low support for mobility in groupware systems!

3.4.1 Micro mobility

A concept which specialize mobility in a constrained setting is micro mobility.

> **Micro mobility:** A way artefacts can be mobilised and manipulated in a limited, or "at hand" domain.

The definition is essentially revolving around the limited domain and the ability for manipulation. An example where micro mobility is implemented (existing) is the patient/doctor-chart in hospitals. Mobility within limited domain is very easy (a paper document in a corridor). The greatest strength is the ability for manipulation, often nearing isomorphism in a sense. The paper can be manually manipulated in numerous ways for example; drawn freely on, making a shape (modeling something ad-hoc), shared between patient/doctor (communication), contain important information, be encrypted ("doctor notation") and so on. This example illustrates micro mobility very well. However it is not a very technical, complex, solution. For groupware to support micro mobility one needs to analyze the situation and *taking micro mobility* into account when doing so.

3.5 Group calendar systems

References

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