Designing Human Protocols

A model of human collaboration in the light of technology

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Introduction

Since the invention of the mechanical device, and later the electronic device, known to us today as the computer, people have been concerned with how to utilize it best in our lives. From times when there was no need for more than 5 computers in the world, the world has moved forward and today the litany is that computers will be everywhere, in our office, in the things we use, in the clothes we wear, and perhaps even someday within our own bodies.

The result of this development is that computers from being something far aloof from ordinary people, has gone on to being something that everybody, in every path of life, need to deal with in order to conduct their lives. From digital watches, to global online communities; from mobile phones to the internet; computers are changing the ways we communicate and collaborate with each other.

Following this development has been a profusion of surveys, theories, and ideas about how we should interact with, and even live with computers. From HCI[1] to CSCW[2], and from CMC[3] to Virtual Communities, people have been working with and developing theories of analysis, work and production in order to chart this virgin landscape of new possibilities.

From practical theories of design development and interface gurus like Jacob Nielsen, to general theories of cognition, language, and interaction, researchers have strived to put into understandable terms, that witch is intuitively understandable to most people – that computers could be the best thing that ever happened to communication.

The idea behind this paper was spawned in the early spring of 1998 as I began a cross-scientific research into the area of interaction and narrative. My goal was to examine the span between narrative computer games and interactive movies, and hopefully to use my findings to elaborate on both phenomena. I quickly realized however that although a plethora of interaction and interactivity theories was available from all areas of the scientific spectrum, none really sufficed lay enough of a groundwork for me to work from.

Through research in rhetoric, narrative, and other human sciences things finally started moving again in the summer of 1999 as I was put to the task of making a collaborative system which could facilitate work and communications between people in a work related situation. In my earlier work, I'd used existing theories of cognition and semiotics to understand the facets of the communicative situation between people and the system, but since my focus now was a more pragmatic one, I started looking at communication from a historical and practical standpoint. What I gained from this perspective was in some sense a more simple and initial sense of what communication was, but also a perspective which to my mind helps in the overall understanding of today's somewhat fragmented and diverse definitions.

Generally you could say that one has a very cumulative definitions problem when working on collaboration through computers. You can not have collaboration without interaction, and you can not have interaction without communication. All of these concepts are therefore necessary in any approach to this area. Though

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[1] Human Computer Interaction (SIGCHI)

[2] Computer Supported Collaborative Work (SIGCSCW)

[3] Computer Mediated Communication

communication is a thoroughly researched area, interaction (and interactivity) is a relatively vague expression[4], especially with regards to computers.

My approach will therefore be to define communication, interaction, and collaboration as part of an overall structure in interpersonal relations, by using and modifying existing theories on all three subjects. Through this process I will try and create a model of both collaboration in general and collaboration assisted by computers.

Though the inspiration for this work is computer-aided collaboration it is not within the framework of this paper to outline strategies for effective collaboration through computers. The purpose of this paper is instead to create a basis for understanding collaboration that will serve to clarify the concept in such a way that effective strategies can be created and implemented on the basis of it.

One reason for this approach lies in the situation of collaborative tools today. From many computer-developers point-of-view, interaction and collaboration has a tendency to be regarded as novel concepts of communication, but from a humanist viewpoint they are ancient and with a rich history of theories and approaches. In order to create effective strategies it is therefore vital that a more comprehensive theory of collaboration be available.

Another reason for this approach is that communication and collaboration are not really dependent on computer aid. Communication and collaboration takes place everywhere, every day without the aid of computers, and though certainly interesting in their potential ability to extent or augment our communication they are not strictly speaking a necessary part of it.

Therefore terms from the world of computers will, as in the title of this paper, be used to the extent that they clarify relations between it and the present work. It is my hope that this approach will serve to clarify not only the nature of collaboration from a human standpoint but also the value of using a humanistic approach, to those working with and applying computer aided collaboration.

The overall purpose is to create a foundation for talking about and working with collaboration, that is both applicable in a theoretical and practical context. First however, some definitions.

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[4] Jens F. Jensen, Interaktivitet, MediaKultur 26, 1997, p.40

Definitions

One of the most crucial tasks in working with collaboration is the definition of the terms used. Communication and interaction are an inseparable part of any collaborative process, and it is therefore also on the foundation of a definition of these two that I will rest my theory of collaboration.

However with a plethora of communicative and interactive approaches and theories to choose from, the daunting task of defining some key concepts in collaboration, becomes downright impossible. Therefore the following definitions are as much a clarification of the theoretical background as anything else.
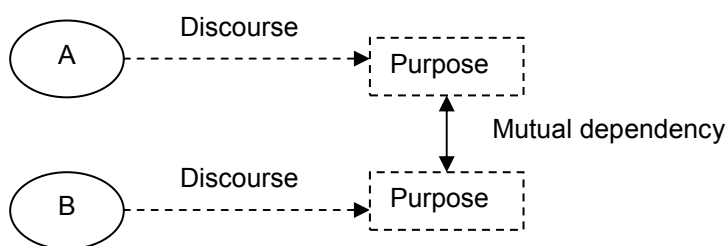
Collaboration

   (To work together with somebody, especially to create or produce something)[5]

One of the first points of departure between the material I was reading and my own inherent opinion was in the definition of the word "collaboration". In most cognitive research[6] and dictionaries[7] the word collaboration is defined as above, with the focus of research most often concentrated around team-building, management routines, and other work related situations.[8]

My focus was more general though, and my need for a definition, which encompassed this more general perspective, was therefore evident. To my mind collaboration was a broad label on a specific kind of interaction, where there is a common goal and an understanding of how to reach that goal. On the other hand collaboration does not really need to result in a specific goal being reached, as f.ex. in a business or in a government, and my definition therefore needed to be more general.

  Two or more complimentary discourses with a common purpose or interdependent purposes (Fig.1).

Fig.1

According to this definition, collaboration is not necessarily linked to work, and not necessarily something that takes place between two human beings. The word "discourse" refers to the combined understanding and social enactment of

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[5] Oxford ALD, 1995, p.219

[6] Michael Spring, report to the National Institute of Standards and Technology on collaboration through computers, Software to Aid Collaboration, 1997

[7] In this case www.dictionary.com

[8] Further reading: Yvonne Wærn, Co-operative Process Management, 1998, Arbejdsgruppens Psykologi, 1993

communication[9], which in the words of Paul Mayer includes "not only forms of mediated communication, but also everyday forms of interaction and consciousness".[10]

The only limitation that this definition makes is in the criterion of a "common purpose" or "mutually dependent purposes". What this means is that it is the common purpose which defines the collaborative nature of an interactive situation. Therefore children's play, moving a piano, and other day to day acts are included in the term while interaction with cross-purposes like a boxing match, where the fighters might have corresponding purposes, but they are certainly not mutual, is not.

A critical opinion on this definition might be that there is no evident mutual dependency in collaborative work, where two people decide to help each other out in completely different projects. My response to this would be that the mutual dependency of the purposes, is the predeterminator for any such relationship. The whole principle of the you-scratch-my-back-I'll-scratch-yours relationship is that in order for the work to start, the participants have to agree, or promise if you will, that the achievement of each purpose is dependent on the other. In other words, in order to achieve help from others, it is sometimes necessary to create interdependency with their purposes in order to reach them.

In order to make a theory of collaboration, it is however necessary to understand the underlying concepts of it. First of all, we need an understanding of interaction, since it is through this that the complimentary nature of several discourses can be created. Secondly we need an understanding of communication. Not because communication is directly linked to the process of collaboration, but because collaboration, like all human interactivity where there is a conscious definition of a purpose, is dependent on our ability to communicate that wish, and the necessary ingredients to achieving it, to others.

Interaction

(To act or have an effect on each other)[11]

Unlike collaboration, which can easily be defined without considering the influence of computers, interaction or interactivity has often been considered a computer-related phenomenon. In this relationship however, the role of the computer and consequently the definition of the word, has often been varying.

In sociology the role of the computer is of course almost excluded completely as it still plays a somewhat inferior role in our day to day interaction. In media-studies the role of a computer, or media, is generally used, although the interaction between human and media is often seen as somewhat different from general human interaction. Finally in informatics the relationship between humans and computers are generally regarded as something completely unique with no real relationship to our general interaction, and hence a new word: "interactivity".

One of the key reasons why interaction with computers and other media can be seen as different from everything else, is of course the fact that unlike all other interaction we know, the interaction here is between a human being and a machine. Though this

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[9] Klaus Bruhn Jensen, The Social Semiotics of Mass Communication, 1995 (Transcript from A Social Semiotic Approach to the Analysis of Computer Media, 1998, p.74)

[10] Same page

[11] Oxford ALD, 1995, p.621

substitution seems simple at first, it is actually quite complex as interaction between humans and the world is a phenomenon as old as man, and not easily changed.

When a new player enters the arena, in this case something which is not quite an object, not quite like a living thing but still with an apparent will of its own, we get confused, and that is no wonder. The result is frustrated users searching for age-old signs in communication from semi-inert objects without any real faculties for either understanding or responding to the signs that we make when communicating. People yell at toasters when they don't spit out the bread, press harder on the remote when the batteries are used up, and speak an encouraging "come on" when the computer doesn't respond, but somehow the machines don't understand.

In order to clarify the difference between this man-machine interaction and the traditional human interaction, many definitions have been put forth, one of these in an article by Jens F. Jensen[12].

He first describes the three most prominent approaches to interaction: The sociological, which focuses on the mutual adaptation of people's behaviour through social contact. The media studies tradition of viewing interaction as the viewers interaction with a given media message[13]; and thirdly the informatics viewpoint of looking at the man-machine relationship as the focus of interaction.

His own approach is to separate the sociological concept of interaction, from the new word "interactivity" which he defines as a so-called continuum[14] of three dimensions, where the man-machine approach is evident:

> *a measure of a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication.*

Jens F. Jensen, 1997[15]

His approach to defining the three dimensions of interactivity is a Bordewijk and Kaam[16] inspired focus on the control of the information being transmitted, the direction of the information stream, and the ability of the media to process and feedback that information.

To some extent this separation of interaction and interactivity is very useful, since it clearly differentiates between the new problems of our interaction with a machine, and our general social interaction. He furthermore establishes that the new in interaction is not within human interaction, but within the abilities of the types of media that we use, since it is these that he seeks to define.

On the downside his separation of interaction and interactivity, is somewhat confusing as it completely separates the two terms and removes their interdependency. One is seen as a traditional sociological phenomenon, and the

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[12] Jens F. Jensen, Interaktivitet, MedieKultur 26, 1997

[13] As will be evident from my definition, I find this definition of interaction to be in fact a form of pseudo-interaction, as the recipient of the media-message, believe there to be actual interaction although no such thing is the case.

[14] Part of the foundation on which he rests his conclusion is an overview of the three definition-types: Prototype, Criteria, and Continuum, of which he chooses the continuum as the most pertinent definition type.

[15] English translation from Computer Media and Communication, Paul Mayer, 1999, p.183

[16] Bordewijk & Kaam, Towards a new classification of TeleInformation Services, Inter-Media, vol.14 nr.1, 1986

other as a property of our new forms of media. But in both one thing is static and must serve as part of the definition: The human being[a].

As mentioned we have a long tradition of interaction, which is not easily shed when interacting with computers. Therefore a definition of interaction, must be a definition, which takes the fact that human protocols and systems for understanding exist into account(Fig.2b), and not one where the whole focus is on the media itself(Fig.2a). We cannot predict in what way we'll be able to interact with computers in the future, as Jens F. Jensen himself points out, but we do know that one of the interlocutors will be a human being, with all the implications of psychology, evolution and change that this encompass.
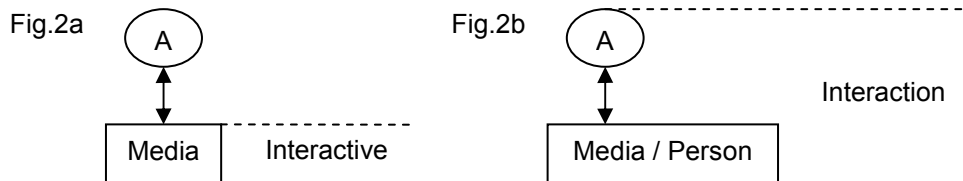
Thus the need for a definition of interaction, which not only takes into account that different media can have different faculties for taking part in interaction, but also the fact that humans have specific faculties for engaging in this activity, is evident.

One such definition can be found in the writings of Klaus Bruhn Jensen[17]. Using a social-semiotic approach he arrives at a model of interaction where the interactivity of a situation is dependent on both the situations ability to facilitate and the participants ability to enact mutual change.

Using a prototypical model of communication, where the semiotic approach is evident, he develops a model of the collective effect of the interactive situation on the semantic understanding of the entities involved.

Fig.3
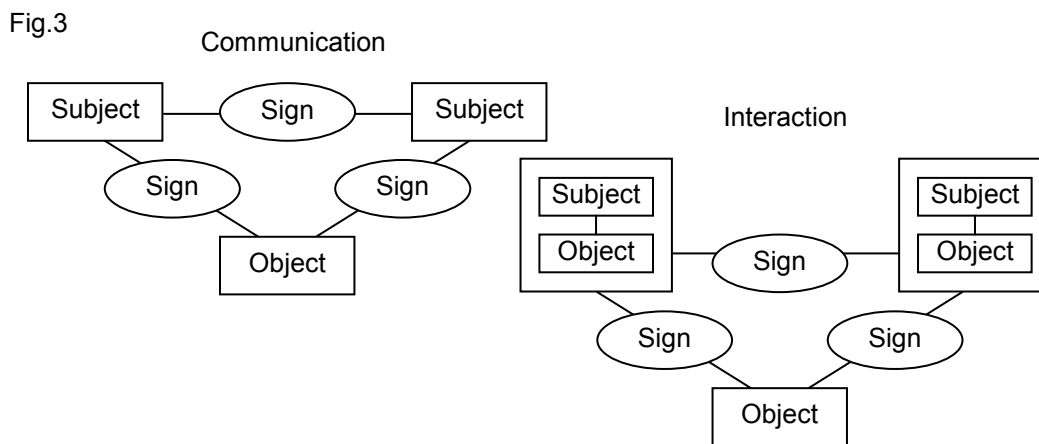
According to Klaus Bruhn Jensens model, and semiotics in general, the subjects of a communicative situation share signs, which corresponds to elements outside themselves. It is through the mutual negotiation and interpretation of these signs that we are able to communicate.[18]

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[17] Klaus Bruhn Jensen, The Social Semiotics of Mass Communication, 1995

[18] Semiotics and Social Semiotics will be discussed further in the chapter Semiotics vs. Cognition.

Focusing on the subject, it is Klaus Bruhn Jensens point that the interactive situation is defined by the ability of the subjects in the communicative situation to objectify themselves and thus to make themselves part of the communicative process.

> *The prototype of interaction is a form of communicative action in which the negotiation of the status of each subject, sometimes as an object of action, is an added element of the exchange.*

Paul Mayer, 1998

This definition of interaction therefore gives us a tool for understanding both computer-mediated communication and interaction with computers because it removes the focus from the media, and exchanges it with a focus on participants of the interactive situation.

Thus media becomes both a participant in, and a facilitator of interactive situations. It is a participant because the continuous negotiation between user and object[19] is an interaction in itself. Meaning that the process of understanding and utilizing computer interfaces, remote controls, and other interactive devices is interactive situations. And it is a facilitator because many media, like writing, phones and computers, have the added ability to facilitate interaction between users at a distance in both time and space.

Following this line of reasoning interaction, with or without a machine involved, is defined by being:

> *The process of two or more entities having a mutual effect on each other*

What we get from this definition, and the theoretical background for it, is a tool for understanding both the interactive situation and some of the difficulties involved in creating good interfaces and consequently good collaborative tools, which will be discussed further. What we do not get is an understanding of how this communication takes place. For this we need to look at communication.

Communication

> (To make known; to transmit)[20]

Communication is of course a very large area to cover. It is the expression of our thoughts in all of our lives, everywhere and all around us. It is the knitting we use to weave our world, and the foundation on which our society is built. As a consequence communication or methods of communication plays a crucial role in almost all human sciences.

The fundamental facts of communication are that we have five senses with which to receive it, and a plethora of muscles and noisemaking systems with which to send it. The nexus of this barrage of communication is our brain, where of course the process of communicating becomes rather complex. What most people agree on, is that we have various facilities for decoding, structuring, labeling, and finally understanding and utilizing the communications that we receive, but how this process takes place, and what parts of it are interesting to look at is where the opinions differ.

In Communication Studies the most common approach is either Cognitive Theory or Semiotics. Semiotics, as suggested in the previous chapter, is focused on the *system* of communication, and thus on the system of coding and decoding information using

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[19] In this case any object with an ability to participate in an interactive situation. I.e. facilitate a perceived change for the user.

[20] Oxford ALD, 1995, p.229

signs. Here a differentiation between the signifier and the signified is made, facilitating a societal model of the creation and deletion of signs also known as Social Semiotics.

Cognitive theory, on the other hand, is concerned more with the *processes* of communication, with the argument that:

> *…the orderliness that is expressed by … models comes from their structure and therefore does not necessarily correspond to the orderliness that is observed in practice.*

<div align="right">Erik Hollnagel, Context, Cognition and Control, 1998</div>

Therefore cognitive theory has a tendency to be very specific and aimed at models of human behaviour rather than models of communication.

But no matter what approach we use we still arrive at the very fundamental question of communication: What constitutes the difference between interaction and communication? In semiotics as well as in cognitive theory, the approach is often to say that our communication is mostly subconscious, and that the conscious communications is but a small part of the effect we have on each other.

But in mediated communication and especially in interaction with computers this understanding is increasingly problematic, as many of the signs that we react to are neither conscious nor subconscious. When we follow the trail of an animal, looking at broken branches are we then listening to the conscious or subconscious messages of the animal, or are we merely interpreting the world we see? To take it one step further you could ask if the heavy air signaling coming thunder is communication?

The answer to this question is to look at the mediation of communication. In studies of history, a differentiation between primary, secondary, and tertiary sources is made, signifying the number of human mediators since the original event. The distinction is made because each human being processes the information and thus distorts the original message, thus we realize that it is the presence of consciousness which to some degree has an influence on the transmission and reception of information.

Furthering this distinction into a definition of communication we could say that there are nine distinct ways to transmit information: A conscious or intentional transmission of information which is received consciously[21], sub-consciously or by a medium with no consciousness; A sub-conscious transmission of information, which is received in the same three ways; Or lastly a non-conscious or immanent piece of information which is perceived in by a conscious mind, by the sub-consciousness or by a non-conscious medium.

Knowing full well that these distinctions are somewhat simplified and in need of elaboration, they nonetheless define the difference between consciously transmitted information and other kinds of transmissions, which is the purpose here. The difference is important because when we begin to talk about mediated communication, the conscious or non-conscious nature of the medium has a lot to say about the mediation.

For now communication will be defined in the diagram as follows:

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[21] This distinction between conscious, and sub-conscious reception, is somewhat artificial as it is commonly accepted that most, if not all, conscious reception, goes through some sort of initial sub-conscious processing. The definition of conscious reception in this case, is therefore defined as reception which is perceived consciously, and not only subconsciously.

Transmission	Reception
Conscious	Conscious
Sub-conscious	Sub-conscious
Non-conscious	Non-conscious
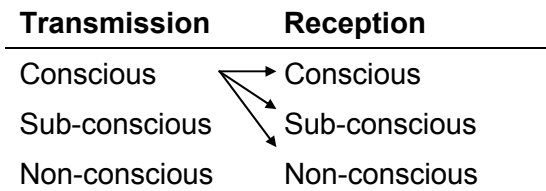
Or in words as:

> *The conscious or intentional transmission of information to a receiver of that information.*

Some will probably wonder why sub-conscious transmissions of information are not regarded as communication. The reason for this is that the distinction between conscious and sub-conscious is important in the usefulness of computers as mediators of information, which will be adressed later.

How this information, consciously, subconsciously or otherwise, is expressed or perceived, what effect it has, and how a media can most effectively facilitate it, is another question.
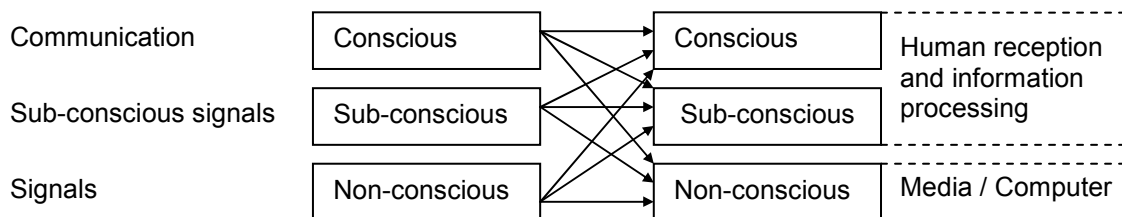
Relating the Definitions

Thus having defined the three words, collaboration, interaction, and communication, we arrive at the question of how to relate them to one another. What exactly is interaction to collaboration, and what is communication to interaction?

In order to do this, let's first look at the definitions:

- Collaboration: *Two or more complimentary discourses with a common purpose or interdependent purposes.*

- Interaction: *The process of two or more entities having a mutual effect on each other.*

- Communication: *The conscious or intentional transmission of information to a receiver of that information.*

What this means is that communication is a specific type of interaction, where there is an intention for the transmitter to have a piece of information perceived at the other end. If we use the diagram from the definition of communication we could say that interaction is the nine kinds of transferal of information, while communication covers the three where there is an intention behind the transferal (Fig.4).

Fig.4 - Interaction

|	Transmission	Reception	
Communication	Conscious	Conscious	Human reception and information processing
Sub-conscious signals	Sub-conscious	Sub-conscious	
Signals	Non-conscious	Non-conscious	Media / Computer

This combination of our definitions of interaction and communication gives us a new insight to the model we used to define communication. First of all on the nature of the transferal of information: Since interaction is the process of having a mutual effect, and not necessarily includes a transferal of communication we can deduce that some types of perceived communication is not communication at all, but interpretation of signals. This leads us to further refine our model of interaction into three subtypes.

Though the definition of interaction is still rooted in the objectification of the subject, the subject is now not necessarily a conscious human subject, but can also be a media with a faculty for being affected by the interaction, like the definition by Jens F. Jensen suggested.

If we should talk about the "interactivity" of a situation we would therefore need to look both at the ability of the participating artificial or living entities to objectify themselves as part of the exchange, and at any mediums ability to transmit this mutual effect. Unlike the historians, who deal in primary, secondary, and tertiary distortions by human mediation, we would need to take both the amount and type of distortion, as well as the channels available by any given media into consideration, in order to determine the overall interactivity of a situation.

Turning to collaboration and combining it with this new view on communication and interaction, we find two criteria of collaboration, which are dependent on interaction: The creation of common or mutually dependent purposes, and the complimentary nature of the discourse leading toward these (Fig.5).

Fig.5
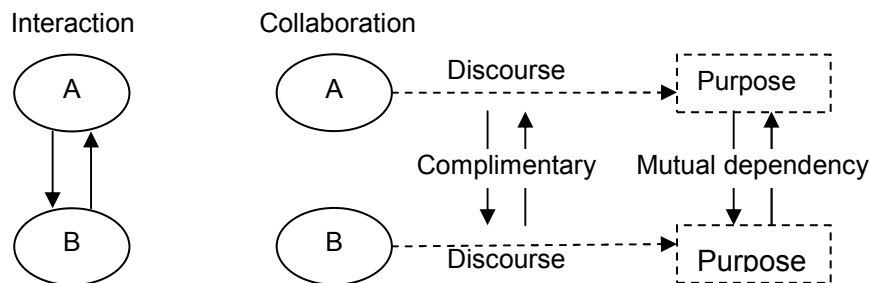
But in making this model we find that the mutual dependency of the purposes must be of a somewhat different nature than the creation of complimentary discourses. A purpose is something created in a conscious mind[22], and therefore something more often communicated, while the complimentary of discourses is something not only achieved through communication, but through the whole spectrum of interaction.

What this tells us is that collaboration can only be initiated by entities able to form a purpose, but that the process of it can include entities without this faculty. If a purpose can be impressed upon an entity to some degree, and that entity is able to work towards that purpose in a complimentary relation to our discourse, then that entity could be said to partake in the collaboration. This of course is very relevant when we include technology later on in this paper.

We now know that any theory of collaboration must take into account both how the complimentarity of the discourses and the commonality of the purposes is created and withheld until these purposes are reached. In doing this any theory of collaboration must draw upon interaction, as the rules by which the process functions, and communication as the conscious manifestation of ideas which guides it.

How this process functions, how it is guided, and finally how we can relate it to an artificial medium is of course another question.

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[22] In Oxford ALD, "an intention, a reason for doing"

A Note on Consciousness

The area of collaboration is of course rather large, considering our broad definition. According to it, collaboration is just about every joint effort spawned by mutual purposes and thus covers everything from two kids playing submarine with two chairs in the yard to 50 dedicated workers building a car.

An obvious question would therefore be, what constitutes the specific nature of a collaborative situation in regards to another? What are the factors and how do they apply to our initial model of collaboration.

In our model we determined that collaboration could only be initiated by entities capable of forming a purpose, and carried out by entities able to work towards that purpose. A purpose and an intention are formed in a conscious mind on the basis of what its world look like. Likewise the continued interaction in collaboration is between two or more entities capable of manipulating that world, and thus the relationship between the entity and its world becomes epivocal to any theory of collaboration.

For humans there are about as many ways to view the world as there are humans, and almost as many theories. From the abstract to the concrete and from the esoteric to the pragmatic the theories span, but determining one useful one in the light of any context can be an arduous task.

Starting with the abstract, Kant would say that the world is a word invented to signify the edges of our comprehended world, as no amount of experience could ever account for the whole thing. His view of the relationship between human comprehension and the world is that we are predisposed with an "a priori" understanding of space and time[23], and of reasoning[24], which we use to determine everything coming through our senses. His opinion is therefore that it is in the experiencing of the world that the world is created.

Moving further down the abstraction level, is the social constructionist who would argue that our world is created through interaction and communication, and always relative to our socially and culturally structured world. Unlike a relativist, the social constructionist believes that we have an influence on the discourse of our social life, and that the world as we see it is a combination of all of our discourses affecting the common whole.[25]

In social semiotic theory, as mentioned earlier, the construction of meaning is contributed through the also socially determined use and development of signs. The reception of each sign is, as also pointed out by several social constructionists[26], determined by the context of its use and in relation to an idea.

For a cognitive theorist, the signs are not necessarily signs at all, but schematics impressed upon our minds through practical and social interaction. We learn to regard something in a particular way, and it is this code, which we bring into a given situation and use to interpret it.

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[23] "Formen der Anschauung"

[24] Actually Kant talks about 12 categories of reasoning within transcendental reasoning.

[25] Kommunikation som psykologisk fænomen, Kasper Kofod, Dansk Psykologisk Tidskrift, 2/1999, s.45

[26] Kenneth J. Gergen, Rom Harré, among others.

At the very bottom of this ladder is of course the pragmatic bottom-up approach of most researchers working with applying cognitive theory and creating GroupWare systems. Here the often-used point is that theory is good but practical surveys are better, and the results are most often very specificly aimed at a particular situation. [b]

This list, far from being comprehensive or in any other way directly applicable to our collaborative quest, is nonetheless descriptive of the wide area covered when trying to find a theory of consciousness to apply to our model of collaboration. It is therefore necessary, in describing an approach to collaboration, to define in which way one approaches the central question of how the entities, in this case human beings, form purposes, create interdependency between them, and interact to make complimentary discourses toward them. In fact which paradigm one uses.

With this established though, further considerations must be taken when involving other entities than humans. When seeing collaboration in the light of constantly changing technology, and in a world where humans are perhaps not the only ones capable of creating purposes and collaborating towards them, it becomes increasingly necessary to define the faculties and degree of consciousness of each entity involved.

The question of consciousness is therefore not only a question of definition, but just as much a question about how relating is done across boundaries of understanding by the entities involved; about what protocols are used so to speak. What this means is that the establishment of human protocols, on the basis of a model of understanding, is necessary not only because it creates an understanding of human collaboration, but also because it creates an understanding about how to relate these to other entities involved in a collaborative effort.

In the following a cognitive and semiotic approach will be taken, in order to make a model of human and computer-aided collaboration, and in that context some basic assumptions will be made. It is therefore important to keep in mind that the approach taken could have been different, had the entities or the theoretical material been chosen otherwise.

A Model of Human Collaboration

Taking the lead from the cognitive approach of Yvonne Wærn[27], we could say that the collaborative situation, once a common or interdependent purpose has been established, consist of a combination of actions, which might go in different directions, but collectively moves towards a common goal (Fig.7)

Fig.7

Information
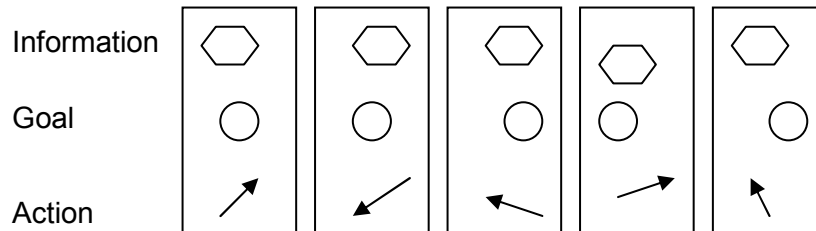
Goal

Action

In this example five people are working in a group. Each has some information, a goal, and is enacting some sort of action towards that goal. It is the sum of these actions, which determine the overall movement of this collaborative situation, and thus it is the coordination, which is essential to collaboration.

Relating this viewpoint to our initial definition of collaboration, you could say that what she is concerned with here is the creation of complimentary discourses. She defines that each person has an individual amount of information to go on, an individual view of the purpose, and thus an individual direction.

The question then remains of how to make these discourses complimentary. With her very practical approach still evident, Yvonne Wærn makes the following list of things essential to effective collaboration:

1. shared model, shared situation awareness (shared understanding of goals, shared understanding of situation); shared = overlapping but not necessarily the same

2. sharing resources – dividing resources among the participants (if one resource can be used by only one person)

3. co-ordination of action – temporal and spatial integration of team action with respect to the controlling system goals

4. shared mental model (of co-ordination) – common understanding of which team member is responsible for which task and what the information requirements are

5. Mutual understanding – cognitive empathy – an individual's understanding of the other person's understanding

With the things that a collaborative situation needs thus established she still has the problem of how to establish them. This she does by turning to the question of control in the collaborative situation. She divides the different types of collaborative control into three types of co-ordination: Commanding, task-allocation, and local co-ordination.

Commanding is when one person is in control of the entire process. Everything is only dependent on the commander's orders, and efficiency is therefore ensured. The drawbacks of this type of co-ordination is that the commander will always become a

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[27] Yvonne Wærn, "Analysis of a generic dynamic situation", 1998

bottleneck, if the complexity of the collaborative situation becomes too big, or the number of collaborative entities too large.

Another model is the task-allocation model, where each task leading towards the purpose is defined in advance. The benefit here is that plans are very good in organizations and when dealing with well known processes, since everybody knows exactly what to do and when to do it. The drawback is that over time most, if not all, collaborative situations have a tendency to develop unexpected situations, which a plan cannot encompass.

The third model of local co-ordination is where the participants in an overall collaborative effort, co-ordinate sub tasks locally in order to fix perceived problems. The drawback here is that without some knowledge of what others are doing; these actions might conflict with what others are doing.

In making these distinctions, and relating them to tasks, organizations and so forth, she is of course following the same line of reasoning, where collaboration is something inherently work and business related, which spurred me away from this approach in the first place. Her analysis of the collaborative situation does however have merit, in that it focuses on the very general processes of working toward a common goal, and furthermore describes some of the most fundamental traits of this process.

Taking a more general approach you could start by saying that her list of five necessary elements in collaboration could equally be seen as two categories: 1, 4, and 5 pertaining to the understanding of the collaborative situation, and the other two as part of the practicalities of it. What this distinction gives us, is a model for distinguishing between the practical nature of all collaboration, and the essential creation of common understanding.

Moving further in her model you come of course to the question of control. Her three types of control would probably be better described as two dimensions of control. One dimension ("command" and "local co-ordination") pertains to the immediate or situational control, what we might label vertical control. The other ("project planning") pertains to the entire process of the collaborative situation, and could therefore respectively be labeled horizontal control.

But what does this tell us? What is the practical nature of a collaborative situation? In the following a model will be delineated.

The Collaborative Situation

Combining the findings of Yvonne Wærn with our earlier model of collaboration we find that the question of collaboration is a problem between the physical processes and the mental ones, and between present and future.

The physical processes are those having to do with the physical manifestations in the process. These are typically actions taken, communication given, and so forth. The mental processes have to do with understanding the collaborative situation. These are all the mental images that need to be shared in order for the collaborative effort to be successful.

In the process of collaboration the mental images of what should take place in the future are negotiated through interaction and determine who should do what in the present. This understanding is manifested in a physical discourse, resulting in a change of the mental images of the situation, which in turn changes the mental images of what should be done.

What this means is that there are four distinct processes at work at any one time. The mental present is a continual processing and renegotiation of the situation

resulting in situation awareness. The physical present is both the actions taken to reach the purpose, and the physical manifestation of renegotiation, i.e. communication. The mental future, is the mental planning of the future based on the situation awareness and awareness of the purpose. The physical future is the communicated plans of what to do coordinated with the other collaborating entities.

	Mental	Physical
Present	Awareness	Actions (+ Communication)
Future	Planning	Tasks

Combining this model with the one delineated by Yvonne Wærn, we find that a large part of it is included in these four processes:

	Mental	Physical
Present	Shared situation awareness, shared understanding of situation, sharing resources. Mutual understanding – cognitive empathy – an individual's understanding of the other person's understanding.	Co-ordination of action, dividing resources among the participants.
Future	Shared model, shared understanding of goals.	Co-ordination of action, shared mental model (of co-ordination).

What this is, is a model of what our model of collaboration should include. It shows that it is through interaction and communication on these four areas, that the collaborative effort progresses.

This means that in order to make a model of human collaboration, we need to consider how the shared awareness is created.

Going back to our semiotic model of the interactive situation, we find that if we stretch its meaning a bit, we can use it to clarify the collaborative situation a great deal (Fig.8).

Fig.8
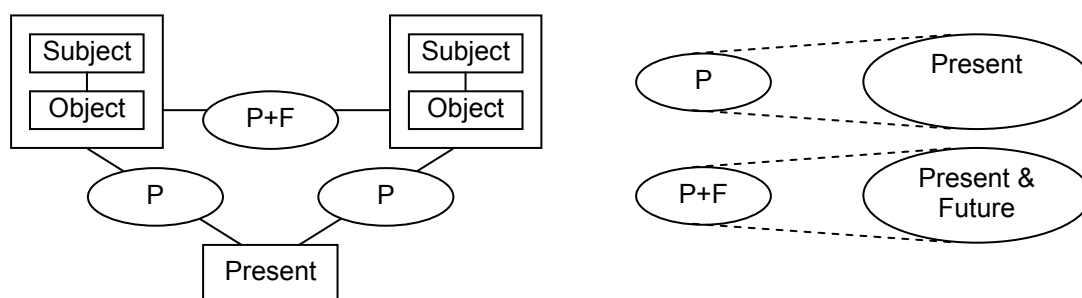
What this model shows is that each entity in the collaborative process interprets the present in a given way, and that interpretation is the basis of their communication. In an interactive situation like this one, the entities furthermore objectify themselves, as objects to be considered in the interactive situation, on the same level as everything else.

Opposed to this the present as a structure of signs, is that of the future. This is a structure based on an interpretation of the present and thus has no real manifestation in the present, but only in the minds of the entities collaborating.

The considerations to be made from this overall structure of the collaborative situation, is of course what the present and future consist of. How can one structure the signs that are exchanged in the collaborative context?

The Collaborative Structures of Meaning[c]

In the previous work, quite a few elements have already been mentioned, which are logically a part of the common structures of meaning to be negotiated if the discourse of each person is to be complimentary of the others.

First of these is of course the purpose, which is the predeterminator for the whole situation. Although predetermined at the beginning, purposes can often be divided into sub-purposes creating a more complex whole. Thus purposes become part of the entire process.

A second structure can be found by the fact that the interactive nature of a situation has as its definition, that the participating people see themselves as an object in the collaborative situation. Therefore role of each person becomes and element as well.

A third structure is physical action, which is almost as important as the purpose. This is the secondary reason why the collaborative situation exists, since it is through the realization, that joint action can reach the purpose, that the collaborative effort is initiated in the first place[d].

Looking at these three fundamental structures we find that, there are other structures as well. Overlapping and mingling with each of these structures almost as meta-structures, but actually just complimentary ways of looking at the same material.

One of these is what Yvonne Wærn labels control. Vertical and horizontal control has a constant influence on the collaborative situation, and is invariably linked both to the individual's role in the collaborative situation, to the formulation of specific tasks, and to the interpretation of the purpose.

The last two structures are constraints and possibilities. The constraints and possibilities are, like control, linked to all three of the fundamental structures, and affects everything. In the model by Yvonne Wærn, constraints are mentioned in the second point in her list, as the sharing of resources, but in our case the term is more general.

Each of these six structures of meaning, according to our assessment of the collaborative situation, has to be considered not only in the present, but horizontally as well as part of a process. Moreover, since we are talking about the context here, the past becomes influential as well, because it is on the basis of this that joint decisions can be made.

But how are these structures of meaning interconnected, and how should we understand them? In the following an attempt at clarifying this rather complex question will be done.

Purposes

Compared to the other structures of meaning, the structure of purposes is perhaps the most easily underestimated, in the structuring of collaboration. In the article by Yvonne Wærn, and in most other cognitive work, it is completely taken for granted or mistaken for tasks and subtasks.

In actuality the structure of purposes, or of goals, is perhaps the most important one of all. It includes the individual purposes of each person, the sub goals set forth as part of the collaborative process, and of course the overall purpose. It is the understandable goal of each task.

Using our earlier example, of two people trying to move a piano up the stairs, you can see all three at work. The overall purpose is of course to move the piano, but as the process commences new purposes present themselves. The two men might agree on a specific strategy and divide labour so that one pushes the other pulls,

heading for the first landing. Thus ones goal is to pull, the others to push, and thus their actions correspond.

In this simple example the goals relation to the overall purpose might seem so simple, they're almost redundant. But in larger collaborative efforts, where the overall purpose might seem distant to the individual participating, the structure of purposes or goals becomes increasingly important.

Another reason of the importance of purpose is its relation to the definition of collaboration. In order for the situation to be collaborative, each person must be able to see his personal purpose as being interdependent with the purpose being achieved.[28]

Roles

The roles of a collaborative situation are to most people one of the most fundamental structures. In the objectification of self, all other structures of meaning are often seen as subordinate to the role.

In many ways the system of roles is just such a system, as it can be seen as a way of labeling each entity, and in creating categories of labels, to define actions, type of control, and so forth which are readily applicable when hearing the label.

By assigning, for example constraints to a role, a role can also be limiting, and with collaborative situations constantly evolving, renegotiation of individual roles can often be necessary. This is quite unlike the military where control is rigidly centralized in order to ensure quick efficiency. Here roles are likewise rigidly defined because a static role ensures efficiency, in that no renegotiation takes place, leaving people free to deal with other things.

Thus the question of role is deeply related to the other structures of meaning, and mostly has a semiotic meaning on its own.

Actions

To most managers the structure of actions is the most important. Labeling each conceived task, and setting them up in a neatly structured plan, is perhaps the most natural thing that comes to mind, when put to the task of leading a large project. If this was the case in real life, the structure of actions, could be made at the beginning of a collaborative effort, and merely referred to until one reaches the end.

Unfortunately the world is not such a structured place[29]. Therefore most collaborative efforts start out with a preliminary negotiation of which tasks should be done, while the process itself is a continued effort to redefine and renegotiate them according to the situations that arise.

This is perhaps one of the most widely discussed area of research and also one of the most obvious in regards to particular fields of collaboration. Often entire diagrams of tasks are made, which should be followed in order to successfully reach ones purpose, whether that purpose is building a rocking chair from IKEA or Windows 2001.

In our case however, structures of actions are deeply related to the structure of goals, and in many cases overlapping. It is the mental understanding of what to do in order to reach the goals set forth.

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[28] Barbro Lennéer-Axelson & Ingela Thylefors, Arbejdsgruppens Psykologi, 1991, p.14

[29] Rob Stammers, Task Analysis and its Relevance for Team Work, p.23, 1998

Control

The questions and considerations regarding control are about as many and complex as those pertaining to action[30], so the following is but a short description of some of the major issues. In our earlier delineation of control we showed that it could be seen as spanning both the present, vertically, and the past, present, and future, horizontally.

This is of course a rather simple model, although it does serve to show the basics of group control. In the present a structure of control is determined, which may or may not develop as collaboration progresses. Horizontally the level of control assigned each person determines how much an influence they have on the planning ahead.

Each person has a level of control over their own situation, but since efficiency of the collaborative situation increases with fewer people in control, hierarchic systems of control are often adopted.

Generally you could say that the level of centralized control is dependent on the complexity of the situation and the need for higher reaction times. At lower levels of complexity or need of higher reaction time, control tends to be most efficient if centralized. At higher level of complexity without so much need for reaction time, control should be more decentralized.

The reason for this is that centralization of control has a tendency to cause "bottlenecks"[31] if either the collaborative effort becomes too complex, or if too many decisions have to be made at the same time.

Constraints and Possibilities

Turning to the constraints and possibilities of a collaborative situation, we find an area that may not at first glance seem like part of the collaborative context, but which nonetheless is one of the most important determinators when deciding what to do.

A shared structure of the constraints and possibilities is important, because it gives the collaborating parties groundwork for reassessing the immediate situation. While most constraints and possibilities are well known - like gravity, or that people like to sleep know and then and can't be two places at once - others - such as the extra strap for carrying the piano in the back of the car - are quite important and may render an otherwise insolvable situation quite easy to manage.

When that is said, constraints and possibilities are also some of the most difficult ones to share, as the selection of things to potentially share is the sum of what the collaborating entities know. From this vast pot, the single item, which is relevant to this particular situation, must be selected and offered to the common structure.

Generally you could categorize constraints and possibilities into a span between the permanent and the time wise specific. The examples of the extra piano-strap and of the allocation of meeting-rooms, are examples of a timewise specific possibility and constraint respectively. At the other end of the spectrum would therefore be the fact that there is only one meeting room, or that the piano is too heavy to lift without a strap.

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[30] Sometimes groups can take on a power of their own, beyond that of the sum of the individual members. In these cases the structure of control can become very important as it determines who can do what. This is most often the case in larger groups like societies, or big businesses where the dynamics are inherently different. J.O.Wisdom, 1993, p.31

[31] Yvonne Wærn, Analysis of a Generic Dynamic Situation, 1998

The Model Assembled

Gathering our knowledge of the collaborative situation and of the structures of meaning, which defines it, we find a model where a lot of the questions about collaboration can be answered. It is a model which shows, that the main part of collaboration can be seen as semiotic discourse between the people enacting it, with some specific structures of meaning created for that purpose.

Taking the lead from our model of the collaborative situation, and inserting our structures of meaning, we get an overview of how the collaborative situation looks (Fig.8).

Fig.8
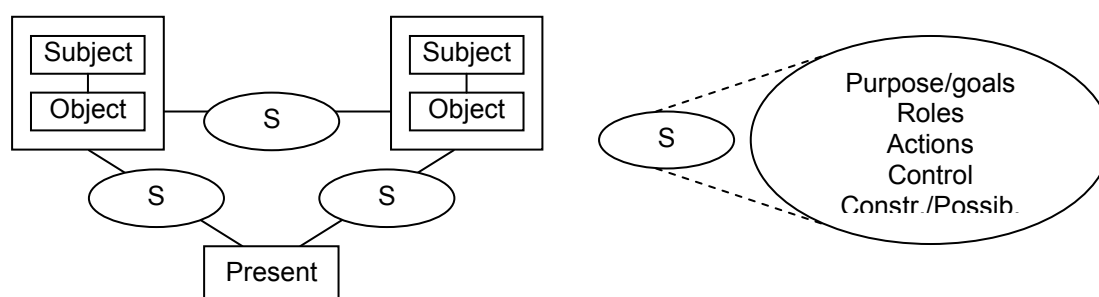
Here the six structures are what is being negotiated between the two subjects collaborating in a specific point in time. Through their interaction with the present, and their knowledge of the past, they assemble a projection of the future, which is communicated and negotiated, according to their, likewise negotiated, distribution of control, to spawn actions.

Each structure is then, almost like a narrative structure which is one of our most basic forms of understanding[32], a structure which puts in order the atoms of our surroundings and projects an understanding of the future.[33]

Each of these structures is overlapping the others as different perspectives on the same material, creating a complete view of the collaborative situation. Each physical object has some possibilities and constraints, maybe giving it a role and an action. Each entity has a role, some control, and a range of possibilities and constraints. Not everything we can think of is necessarily covered by all six structures, but all are covered in some way or another.

What we know from this model is that subjects, by interacting with the world and objectifying themselves in it, can form a purpose. Through interaction they find that the purpose can be considered mutually dependent or common with someone else, and that collaboration with that person can further their own achievement of that purpose.

By initiating that process they need to negotiate an agreement on what the purpose is, what their individual roles should be in achieving it, what actions should be taken, how control should be distributed, and a common understanding of the constraints involved. The process then becomes a continual renegotiation of these areas, as each person interact and change through self-objectification.

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[32] Helle Hellmann, Verden skabes med historien, Politiken, Onsdag 22.december, 1999, 2.sektion, s.6.

[33] More on this in A Note on Context

Since this collaborative effort is a process, each of these structures is vertically and horizontally distributed as experience to build on, overview of the present situation, and plans for the future. It is the knowledge of this area, which constitutes the "situation awareness", or "cognitive empathy" which Yvonne Wærn is talking about.

The importance of these structures is not to be ignored. Of course if you have no common purpose, there could be no collaborative effort. But if you had no role, there would be no way of identifying with that effort. If you had no idea about actions, nothing would be done. If you had no control, you would probably end up in the same end of the piano heaving without getting anywhere. And if you had no idea about the constraints and possibilities, you could be stuck with that piano on the stairs, heaving and pushing, but not realizing that the stairs where too narrow.

These examples may seem somewhat superfluous, as the structures of meaning are created almost instantly when we assess a potentially collaborative situation. They're the things that go through our head before we agree to collaborate, and are then negotiated continuously as we do so. But as shown, we could not collaborate without them. They constitute the context from which we derive our understanding and our sense of what to do, and therefore their common nature is epivocal to collaboration.

Thus it is through this process of "situation awareness" leading to renegotiation of the six structures, that the discourses of each collaborating entity is made complimentary. Not that complete complimentarity is something easily achieved. In many cases of collaboration, noise and misinterpretation[34] creates dissimilar structures of understanding, leading to confusion and misunderstandings. But in our continuous interaction, and through our cognitive abilities, we observe, we interpret, and we communicate, making the process possible in spite of our differences.

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[34] Erik Hollnagel, Context, Cognition, and Control, 1998, p.29

A Note on Context

In historical social studies of tribal societies the word "cosmos" is often used to describe how tribal people develop and relate to the world. The cosmos is the world they construct around themselves to understand the world, the rising of the sun, the sounds of the night, and all the other things that need explaining.

Through this context they recognize things, and categorize them into objects through structures of understanding. They tell stories of the world creation, of the spirits in the trees, and the cycle of life, which in turn becomes both their religion and their basis for understanding new things.

Seen from a historical standpoint the cosmos might seem primitive, but all through history this dilemma of how much importance contexts has on our understanding has been present. Kuhn criticizes the search for an objective scientific method, by pointing out the dependency of scientific work on the context of it, in his theory of paradigms. Nietzsche and Ortega y Gasset among others almost creates a theoretical vacuum of solipsism by stating that everything is relative to a specific situation and a specific situation, while historicism[35] is a touch lighter stating only that everything is relative to the historical context.

For Nelson Goodman, who is obviously inspired by the possible world-semantics of Leibniz and Kribke, what we define as context here, is actually entire worlds onto themselves in an almost ontological sense:

> *"The physicist takes his world as the real one, attributing the deletions, additions, irregularities, emphases of other versions to the imperfections of perception, to the urgencies of practice, or to poetic license. The phenomenalist regards the perceptual world as fundamental, and the excisions, abstractions, simplifications, and distortions of other versions as resulting from scientific or practical or artistic concerns. For the man-in-the-street, most versions from science, art, and perception depart in some ways from the familiar serviceable world he has jerry-built from fragments of scientific and artistic tradition and from his own struggle for survival. This world, indeed is the one most often taken as real; for reality in a world, like realism in a picture, is largely a matter of habit."*

<div align="right">Nelson Goodman, p.20</div>

Therefore the cosmos, paradigm, perspective, or world is a basis of understanding, a common context from which we derive understanding, which is inherently individual and largely social in nature. We're still tribal people and our viewpoint is more linked to our background, experience, and place than to an objective and truthful reading of the world around us.

In our model of collaboration, we defined six structures of meaning, which constituted the context of a collaborative situation. This is of course a simplification, and to some maybe, a gross simplification, since we do not take into account the part of the context that has to do with outside structures or the complexity of human thought. We don't consider personal background, systems of control, like in the military or a business, social relations, and so forth. And we do not take the emotions, the feedback systems and other psychological and cognitive aspects into account either.

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[35] E.Troeltsch, "Der Historismus und seine Probleme", Tübingen, 1922

The context here, however, is not to give a full account of collaboration linked to all the systems that has an influence on the individual collaborative situation, or to make a detailed account of the processes of the mind during collaboration.

As stated in the beginning, the purpose here is merely to create a model, a framework of the essential elements of collaboration, in order to give a better foundation for understanding the problem of creating *technology assisted* collaboration.

A Model of Computer Assisted Collaboration

One of the great problems in creating collaborative computer systems in general has always been that no matter how many e-mail functions, common calendars, and internet video-phones one applied, it always ended up being the same confusion of functions that no one could effectively utilize in collaboration.

What we have found in our quest for a model of collaboration is that collaboration is inherently dependent on the creation of common structures of meaning, of a common situation awareness if you will, that computers simply do not replicate.

What these two facts tell us is that the problem of computer aided collaboration is not only a question of interface, but lies in the information structure itself. Most collaborative tools, even Microsoft Project, use a tree structure to describe a project, but each person working on the project will not necessarily see the meaning of such a comprehensive structure when doing the actual work.

The often used solution is merely to assign tasks to each person, making it a matter of that persons own interests to find out in what way these tasks fit into the whole. But as we found in our model of collaboration it is not only a question of finding ones role in the collaborative effort. There are completely different ways of looking at the collaborative situation depending on which structure of meaning you use.

The other often-used solution is to make everything about a project public knowledge. But his approach is almost as bad, because instead of not informing, you overinform, making it impossible for the involved people to find out what part of the project applies to them, and how it is related to the work of others.

What is needed is therefore an information structure which not only holds the entirety of the project, but which is flexible enough to accommodate each persons informational and structural needs, while not distorting the overall common structures of meaning which constitute the collaborative situation.

This is where the object oriented database structure is relevant. An object oriented database, is a database where each piece of information is not directly linked to anything else. Here the individual piece of information is not locked in a particular structure but has an unlimited number of attributes defining relations to other information, to specific actions, roles, possibilities, constraints or any other structure one could choose to put it into. Thus the information structure becomes flexible and fluid enough to hold as complex structures as those generated in a collaborative environment. Moreover they become able to accumulate the different stages of these complex structures as the collaborative effort progresses.

This connection between computer structure and mental structure is actually nothing new. In Topographic Writing, Jay David Bolter writes:

> *The computer can maintain such a network of topics, which reflects the writer's progress as he or she trims the network by removing connections and establishing subordination until there is a strict hierarchy.*

Jay David Bolter, Topographic Writing, p.300[36]

Though he's talking about the creative act of writing, the point he's making is that the computer is able to hold the seemingly random thoughts of the writer while the text is being created in a topological network reflecting the writer's mind.

[36] From Computer Media and Communication by Paul Mayer, 1999

What we learn from this is that, if the conversion is made from the instantly created structures of meaning in the collaborative situation, and updated as the collaborative effort progresses, it would be an invaluable tool in collaboration.

But how is this done? What are the conditions of a computer assisted collaborative situation as compared to an ordinary situation of collaboration?

The Collaborative Situation

Taking the approach of Doug Engelbart[37], and J.C.R. Licklider[38] you could say that one of the most important aspects of analyzing the man-computer nexus, is to make a comparative analysis of the two. In this case however we do not have the immediacy of an interactive situation in mind, but rather a model of collaboration we need to apply to this nexus.

In regarding the computer as a potential media for containing a copy, so to speak, of the collaborative structures of meaning, we could start by implementing this in our initial model of the collaborative situation (Fig.10):

Fig.10
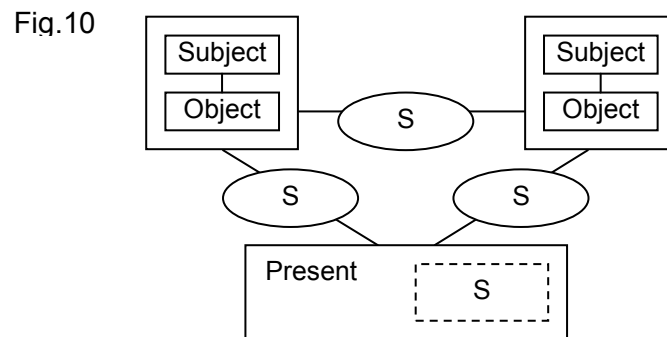
Here the structures of the collaborative situation are recreated in the actual situation. But how does this influence the collaborative effort? To understand the intricacies of this dilemma, we need to take a little detour and look at some of the important elements to consider in the relationship between man and computer.

Interface

The first is the element of what we could label interface[39]. In light of our model of collaboration we find that the most crucial element of collaboration, is the creation of common structures of meaning within the collaborative context. In this process interaction is the most important element because it is through interaction that the common structures are created.

Looking at our initial definition of interaction however, we find a problem when it comes to interaction and computers. In interaction between two people, subconscious messages are as much a part of the interactive process as the conscious formulation of communication. What this means is that although the computer today may be able to receive and transmit many forms of communication

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[37] Douglas Engelbart, The Augmented Knowledge Workshop, 1988, p.216

[38] J.C.R.Licklider, Man-Computer Symbiosis, reprint from Computer Media and Communication by Paul Mayer, 1999, p.63

[39] This is of course a large area of HCI, but in this case where our focus is only those factors pertaining to collaboration, I have taken the liberty of ignoring everything but the most relevant.

they are still not able to interact with us on a subconscious level or in any other way to interpret any other than our consciously transmitted signals.

In the context of collaboration, this is a very serious problem as it renders the computer-assisted collaborative efforts dependent on the involved peoples ability to consciously communicate and structure their thoughts.

The consequence of this is of course that the computerized structures of meaning, can never be an exact duplication of the actual structures. In fact you could say that even if subconscious interaction was possible, this level of duplication could not be mediated as the structures involved are far too complex and wide ranging, as earlier mentioned[40], to become anything but vague approximations when transmitted to the computer.

On a more positive note, the interface is also one of the fastest developing parts of the computer-world at the moment. When hypertext became common it was hailed as giving the "ultimate freedom"[41] in the creation of text, but today even more flexible systems are available.

In new types of interface structures (Fig.10) and databases the object oriented approach to structuring information is becoming increasingly popular, as it is an extremely flexible way of organizing data.

Fig.10
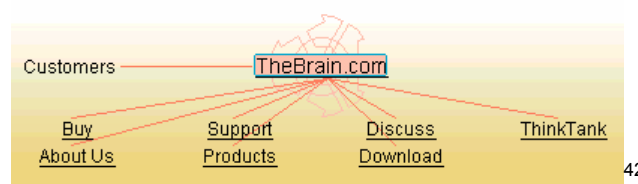
What happens when this type of data-structure is coupled with interfaces like this, is that not only the internal structure of data becomes flexible, but that the interface itself can take on whole new forms of representation. The result can be compared to hypertext where each link is a variable and each page can take on a different meaning depending on how you view it, who you are, and what your purpose is.

Immediacy

The second element to consider is that of immediacy or input/output ratio. From my practical work on making collaborative tools, I have seen this problem materialize many times, and often wondered if it was even possible to make computer assisted collaborative systems because of it.

The gist of the problem is that people are impatient beings. The model of collaboration described so far takes, as also mentioned, only a matter of seconds to initiate and begin in most cases of day to day types of collaboration.

In computer assisted collaboration however, the conscious formulation of what the purpose is, who should do what, and how it should be done is followed by another person, having to find that information, read it and utilize it. This is often a lot more complicated than simply talking to the guy or doing it yourself, and therefore you end

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[40] In "A Note on Context"

[41] Jay David Bolter, Topographic Writing: Hypertext and the Electronic Writing Space, in Computer Media and Communication by Paul Mayer, 1999, p.294

[42] The Brain, is based on an object oriented approach to data-handling. Each node in the structure can have links to any other node in the structure. (www.thebrain.com)

up putting a lot more in the computer than you get out, which is why Microsoft Project will never be a favored tool for plumbers.

The background for this problem is to be found in the inherent immediacy of people. We think of something far more often than we think of communicating it, and we simply do something, far more often than we look something up before doing it.

The consequence is that computer assisted collaboration is often either very informal in nature within a very specific field, which makes the requirements for interaction a great deal smaller. Or they're so big, that the inconvenience of entering all the information is outweighed by the benefits of being able to look everything up again.

One of the most interesting developments in computer technology today however, is the development of new types of hardware and protocols. From the PalmPilot[43] to WAP[44] and Bluetooth[45] new technologies are transforming the computers to become a part of our lives instead of something we have to sit down in front of a screen to experience.

Whatever one thinks of the societal consequences of these developments, the potential for creating better collaborative tools are staggering. Information input and output, no longer has to take place in front of a computer, but can soon be spoken into the second button on your sleeve, making it instantly available to others if you wish it to be so.

However fascinating the technology though, there is still no real way around the basic problem of the computers not being able to interpret or adequately mediate our subconscious communication. In cases where the complexity of the collaborative situation is not beyond what people can cope with on a personal basis, the physical presence is therefore always best. Or said differently, although the plumbers might automatically time their work and their bills are sent out automatically, they'll still do better collaborative work by being present.

Mediator

One of the most important, and often mentioned, elements of computers is their ability to mediate information spatially and temporally.

Spatially the computer, or more pointedly the Internet, is unique in that it can mediate over great distances. Today the advantages of this are being utilized by everybody from the programmers of India rendering their services all over the world and the plethora of international internet businesses, to Mr. and Mrs. Smith e-mailing their son in Hong Kong.

In respect to collaboration, this removal of physical constraints on communication are one of the greatest, and most often talked about, benefits of incorporating computers in collaboration. The problem in spatially mediated collaboration however is that the ability of the collaborating entities to fully interact is limited, thus making the online collaboration tools epivocal to their success.

In the light of the earlier mentioned problems in interacting through computers, this problem is not to be ignored, but in many cases it is, because the conscious communication is enough to create an understanding of each other. These are often

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[43] www.palm.com

[44] Wireless Application Protocol, a protocol for dynamic interaction through wireless applications (mostly mobile phones).

[45] www.bluetooth.com, technology for wireless communication between small appliances, enabling them to communicate with each other.

cases where the collaboration undertaken is within so familiar grounds or so simple that the more intimate collaboration is not really necessary.

Temporally the computer is equally useful in that it can hold information readily available for as long as one deems necessary. It does not forget, and is therefore an excellent medium for dictionaries, roadmaps, and other encyclopedic media.

The temporal ability to store information is probably one of the computer media's most underestimated potentials when it comes to collaboration. Unlike other types of media the computer is not only a holder and distributor of information, but can actually take part in the collaborative effort given the right information to do so.

What this means is that in repeated collaborative situations, especially those taking place inside the computer, like software development, the computer can actually duplicate the same structures over and over again, refining each element of the process. After a while it may point out problem-areas out before they arrive and do some of the more tedious tasks.

Given that this kind of information could be put inside the computer, which of course is one of the problems, the ability to accurately reproduce, not only the current status, but the entire history of the collaborative effort, could be of epivocal importance to developing systems able to assist in collaboration.

Today these kinds of systems are slowly beginning to emerge. By far the largest part, if not all, of them are very specific to different types of work or to specific businesses, but as the flexibility of computer-systems increase so will the flexibility of these types of software.

The Collaborative Model Revised

After this reconsideration of the collaborative situation, we find ourselves in a situation where our previous model is not enough to fully describe the processes taking place in the nexus between human collaboration and computer assistance. The reason for this is mainly that we now have four areas where processes are taking place.

Fig.11
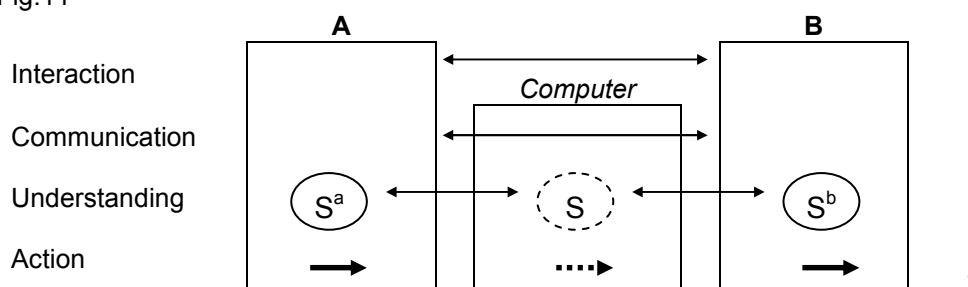
The first area has to do with the general collaborative interaction, which is the basis of our previous model, and takes place outside of the computer. In a lot of cases this is of course not possible due to physical distance, but it is included here because it is still a factor. As shown by the arrow on the far right the process of interaction affects the understanding of each person and then their actions.

The second area is that of computer mediated communication. Here the interaction takes place through the computer and so the media, if able to do so, has the possibility of adding the communication to its model of the collaborative situation.

The third area is where the common structures of understanding are being created. From both online and offline interaction, the collaborating people have created an understanding of the collaborative situation, and from the communications and the physical input the media has been able to assemble an approximation of it. This approximation serves doubly to ensure the collaborating people that their individual understanding is in fact complimentary to the others.

The fourth is the physical action. Here each person performs actions according to his understanding of the situation. In cases where the work being done is within the computers ability to participate, it too, still depending on it's programming, is able to perform some of the actions.

It is of course not quite possible for a computer to react to an understanding of a particular situation and enact actions accordingly, but it is possible for it to learn that a particular action always follows a particular event or series of events. And who knows, with the current advent of neural networks able to learn from experience, maybe independent action will be possible.

Through this model we finally see the role of computers in collaboration depicted with it's potential for assisting in collaboration included. Though flawed in many ways when it comes to communication, the computer is nonetheless vital when it comes to keeping track of information, and therefore indispensable in collaboration requiring many people and much data.

As we have seen, the problems and considerations, both in deciding when computer assistance is needed, and in creating the right computer system to manage that project, is not only a question of creating the right interface or the right system. It is just as much a question of accurately analyzing and utilizing the structures found in human thought processes and interaction with their surroundings.

So far most practical collaborative tools have reached the level of facilitating communication, a few, such as MicrosoftProject is attempting to go into the area of task structures as well. But in most cases this is where the integration stops. No system so far utilize the structures of understanding to make a system fully integrated, as this model shows they have a potential to do, and as long as that is not the case, computer assisted collaboration will be more hard work and bad input/output rates than actual assistance.

Conclusion

Though the processes and the structures delineated in this paper, may seem strange to some, the project of not only dealing with human communication, but also with structures of meaning and interaction, should not be.

As mentioned earlier Jay David Bolter have thoughts in this direction, seeing hypertext as a topological manifestation of thought[46], and already back in 1960 J.C.R. Licklider wrote:

> *The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information handling machines we know today.*

<div align="right">

J.C.R. Licklider, 1960[47]

</div>

The project here is therefore not one of breaking new ground, but more one of reviving the approach to computers as something with a potential for being more than an information processing machine.

The route taken, through a liberal treatment of semiotics and cognitive analysis, and through blithely ignoring many factors of interaction, was deliberately chosen. Not because the ignored factors were deemed unnecessary or irrelevant, but because it was the span itself, the span between creating actual collaborative systems and the theories of human interaction, that was the target of this investigation.

The reason for this is that the gulf between these two areas of expertise will have to be bridged if a genuine improvement of collaborative and communicative tools is to be made. At the moment important research is being made, on the basis of thousands of years of thinking in the area of human mental processes and interaction. And yet the actual work implemented is Office2000's dynamic menus that no one can use, online collaboration tools offering e-mail, and joint calendars which does not accord with anyone's work patterns, and new interface systems offering nothing more than fancier graphics on the basis of the same old data structure.

Thus the project is to try and connect these two things. To create a link between the theoretical work being done and a model applicable to an actual piece of software. To create a framework for talking about and examining, the practical implications of some of the things we know. Because, in the words of Doug Engelbart:

> *Without such a framework, tailored for the goals, values, and general environment of the respective discipline, there could be no effective collaborative work. Furthermore, if such a conceptual framework did not already exist for a new type of research, then before effective research should be attempted, an appropriate, unique framework needs to be created.*

<div align="right">

Doug Engelbart, The Augmented Knowledge Workshop, 1988, p. 191

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Whether my attempt has succeeded or failed is not easy to say, since the work done here is but a small step in this direction. At the moment I'm applying some of the principles described here to an actual system of collaboration[48] based on an object oriented database. My hope is that the experience gained from this project, and from

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[46] In Computer Media and Communication by Paul Mayer, 1999, p.300

[47] In Computer Media and Communication by Paul Mayer, 1999, p.60

[48] www.hotmanager.com or hotmanager.deus.dk

my continued research in this area will be fruitful, and that I can have my model proved or disproved in a Popperian sense through my practical work.

Successful or not, the goal remains that one day we'll have computer systems with the ability to communicate not only on the surface, but through actual duplication of our mental structures, because then, and only then, will the computers truly have what we could call human protocols.

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[a] In saying that one of the interlocutors will be a human being, I of course neglect the fact, that it is not the human being per se, which is necessary for an interactive process, but rather the presence of an entity with a faculty for changing behaviour as a result of the interaction, which will be evident from my final definition of interaction.

[b] Examples of this are "Utilization of Information Technology in Navigational Decision-Making" by Leena Norros and Kristiina Hukki, "Creation and Loss of Cognitive empathy at an Emergency Control Center" by Henrik Artman and Yvonne Wærn, "Team Decision-Making and Situation Awareness in Military Command and Control" by Henrik Artman, "Software to Aid Collaboration: Focus on Collaborative Authoring" by Bordin Sapsomboon, Restiani Andriati, Linda Roberts and Michael B. Spring, and many more found in Co-Operative Process Management, Yvonne Wærn et al., 1998

[c] In determining specific structures of meaning within a collaborative effort, I am also inspired by J.O.Wisdom who in Groundwork for Social Dynamics says:

> *…we have aspects of a society that can usefully be detached from the rest provided the detachment does not go too far, that is, provided we realize that in certain circumstances this detachment cannot be completely effected.*
>
> J.O.Wisdom, 1993, p.4

Here and in the following pages he is arguing that a society, or any other social construction, can be divided into subsystems, which gives a better vantage point for understanding the whole.

[d] An important thing to note here is that the action mentioned here, is not to be mistaken for the manifestation of the discourses by the collaborating entities. The action is the part of the manifestation that has to do directly with reaching the purpose, while the entirety of the manifestation of discourse includes communication on that topic as well as action in other areas. Using the earlier example of the piano, action is walking to one end and lifting, while the manifestation of collaborative discourse is discussing who should do what, and the manifestation of general discourse is talking to the old lady, trying to get by, about her missing cat.