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Formalization and rationalization of communication

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Abstract

In Computer Science, conceptual modelling and formalization are the basis for developing automated systems, "intelligent" or not. It is often taken for granted that formalization is possible and desirable. In the Language/Action perspective, this assumption has been challenged. The Language/Action perspective promotes "communicative action", in the sense of Habermas, as the building block of inter- and intraorganizational communication. In this paper, we want to discuss the issue of formalization from the broader perspective of rationalization. In this way, both the positive and negative sides of formalization can be more clearly seen. We illustrate this by means of examples from group support systems, workflow systems and software agents.

1 Introduction

The Language/Action Perspective is a way of thinking that looks at communication in terms of what people DO with words: requesting, declaring, promising etc. Right from its inception, there has been discussion on the question how far one should and can go in formalizing communication models. For Winograd and Flores, formal models are associated with a classical rationalistic view of cognition and at least suspicious, although they do not go as far as certain opponents who dismiss formalization completely [17]. However, there is also the work of Johannesson [2] and our own [5, 18], among others, in which formal logic is used to capture the semantics of communicative actions, and that places itself in the Language/Action tradition as well. The question that we want to discuss in this paper is whether and to what extent formalization is the right way to proceed. The question can be made more precise by distinguishing at least the following three situations for which we might want to use formal semantics of communication.

1. Formalization of communication between persons.
2. Formal semantics of communication between systems that are meant to support the human communication.
3. Formal semantics of communication between systems that is meant to replace human communication.

Although the situations are related, they each have their own characteristics and their own special topics of interest. E.g. indirect speech acts are an important topic for human communication but can be ignored for communication between computer systems.

Of course any communication between computer systems is formalized by definition. The question in this case is how to embed this formalization into a description of the human communication that it is supposed to support or replace.

Our conjecture at this point is that to do this, we also need some formal representation of (part of) the human communication.

We will answer the general question on whether to formalize the semantics of communication and to what extent to do this, by first looking at two major sources of inspiration, the work of

Heidegger (as applied by Winograd and Flores) and the work of Habermas. Both philosophers touch upon the question of formalization and rationalization explicitly. After that, we will describe three types of applications in organizational computing, and discuss the feasibility and the usefulness of formalization.

2 Limits to formalization

In the following, we will use the term "formalization" for the process in which a certain piece of knowledge (for example, a business practice) is expressed in a unambiguous form. This unambiguity applies to both form and content. With respect to the form, formalization means that the expression obeys to a well-specified syntax. An example is the replacement of a free-text letter by a form with specific fields. With respect to the content, formalization means that the semantics can be described completely and unambiguously. Formal logic is one way of describing formal semantics, but there are of course other means as well. Formalization is a necessary condition for automation, since a computer is a formal device. However, the required degree of formalization depends on the degree of automation: in some cases, formalization of the form is sufficient (e.g. a Lotus Notes workflow application).

2.1 Understanding and cognition

In their influential book *Understanding and Cognition*, Winograd and Flores not only introduce the use of speech acts in modelling communication, but also present a fundamental critique of the rationalistic view of cognition that underlies most work in Artificial Intelligence and Computer Science. Drawing on philosophers such as Heidegger, they attack the idea that we are able to make complete models of (parts of) the world that can be used subsequently for building intelligent systems incorporating these models. For example, they argue that (p34-35)

- our implicit beliefs and assumptions cannot all be made explicit
- practical understanding is more fundamental than detached theoretical understanding
- we do not relate to things primarily through having representations of them
- meaning is fundamentally social and cannot be reduced to the meaning-giving activity of individual subjects

The world is encountered as something already lived in, worked in and acted upon before we start thinking and speaking about it. World as the background of obviousness is manifest in our everyday dealings and every possible utterance presupposes it. That which is not obvious is made manifest through language. That which is obvious is left unspoken, but is as much a part of the meaning as what is spoken (p58).

Taking such an ontological stance makes clear the futility of any attempts to arrive at complete formalizations. but it does not rule out the use of formal models. The point is that there are regularities in language use. "This does not mean there are no regularities, or that formal accounts are useless" (p64). The issue becomes one of finding the appropriate domain of recurrence. An example of such a recurrent pattern is the basic conversation for action that is found back in the Coordinator and also in for example the method DEMO (dietz).

2.2 An example: the Capability Maturity Model

The theoretical argument above can be exemplified by a model that has originated from the practice of information system development, the widespread Capability Maturity Model ([16] of the Software Engineering Institute. This model enables one to evaluate the current situation in an organization with respect to system development. The CMM distinguishes five levels of maturity:

1. initial: nothing specified, ad hoc use of tools and methodologies

2. repeatable: there is some stability that makes that processes are no longer dependent on individuals.
3. defined: the design process has been defined and described explicitly. System developer are trained in this method.
4. managed: the design process is not only defined, but also managed according to explicit performance and quality metrics.
5. optimizing: continuous improvement of the process

The model not only gives a method of assessing the current situation in an organization, but also indicates the steps that have to be made in order to reach a next-higher level.

The focus of the Capability Maturity Model is on software development, but it can be applied to any process, including the business processes that information analysts are modelling. For example, the model suggests that learning is only possible after some repetition; in other words, the vantage point for analysis is the recurrent pattern, as Winograd and Flores indicated as well. A next step is to *define* and this is the point where an information analysis is most suitable. Definition can be regarded as a collective linguistic action that explicates what has been implicit in the background up to that time. It is a collective action, that requires the involvement of all the parties, even if there is only one person who does the actual writing. We also see here an important motivation for definition: to train new people that miss the experiences of the people already on the job. More in general, cultural reproduction is to be taken into account as one of the motivations for formalization (this point seems to be missing from the account of Winograd and Flores; and also in other language/action theories, "conversations for learning" have not received much attention)

After definition, further learning is still possible, not so much by theoretical analysis, but by systematic evaluation of the results in practice. The motivation is in this case economic: to increase efficiency and process control, in line with the Western rationalistic tradition (see below). Automation of the processes seems most feasible when the organization has reached the latter stages, although partial automation support can be given in earlier stages as well. We will come back on this issue later.

It is worth noting that the higher levels of maturity can only be reached in a more or less stable environment. As Winograd and Flores argued, the everyday practice is shaped against a certain unquestioned background. "Breakdowns" do occur when assumptions no longer hold. At such a point, the practice, and our interpretation, must be adapted. In a dynamic environment, this will happen continuously. In such a case, it does not make sense to define the process in all details, as this would only lead to inflexibility.

2.3 Why formalize, after all?

Although we basically agree with Winograd and Flores' way of thinking, we do observe at least one weakness in their presentation, the fact that they do not make a clear distinction between practical thought and theoretical (scientific) thought. It is not clear whether they write for information analysts and engineers or for information (computer) scientists. They note that much of the study of logic and language gives primacy to activities of detached contemplation (p33) and they do not want to disregard this kind of thinking but put it into context. The question is whether they view their own work also as "detached contemplation", thus putting it in the line of the scientific tradition, or prefer another position. For scientists, there is no other way of dealing with reality than by representations and formal models, also for those scientists that are well aware of the fact that this understanding is only secondary, and hence will also be modest in their claims about the application in practice. Scientific analysis is only possible after abstraction. This is the source of its limitations but also its power.

The virtue of the Heideggerian viewpoint is that the requirements for formalization are put into context, rather than taken for granted. However, its weakness is that it does not give a positive incentive for formalization. Winograd and Flores explicitly state that the use of formal models should not be excluded, but this is not really encouraging. As we have seen, positive incentives can be:

scientific progress, and cultural reproduction (teaching). The theory seems to be neutral with respect to these factors. In the next section, we will go into another pillar of the Language/Action Perspective, the philosophy of Habermas, that suggests a way of analyzing both the positive and the negative results of formalization by introducing the concept of rationalization.

3 Rationalization and communication

3.1 Rationalization processes

Rationalization is a key concept in the philosophical work of Habermas ([8] [13] [4] [19]). Rationalization should not be taken here as "disguising or concealing underlying motives and intentions", as it is often used in everyday language, but refers in the first place to a particular development in Western society in which the reasons for actions are no longer primarily determined by traditions, but have to be given more explicitly. What Habermas (in the line of Weber) means is that modern culture has made available a "rationalized lifeworld" - one in which actors consistently carry the expectation that the various validity claims raised in speech are opened for discussion and cognitively distinguished ([19]). As such a rationalized lifeworld emerges, an increasing number of spheres of social interaction are removed from the guidance by unquestioned tradition and opened to coordination through consciously achieved agreement. In other words, in the lifeworld we can notice an increasing independence of procedures of justification from traditional normative contexts and an increasing reliance on communicative action, also called "action toward understanding" (Verständigung). A good example in this respect is the participation of the employees in the decision-making process of a company. Traditionally the director of a company could make decisions without having to give a justification for them. Nowadays, this justification through tradition (and structure) does not work in the same way. Also directors can be requested to justify their decisions by the employees.

Rationalization implies on the one hand that tradition loses its justifying power, and on the other hand that different validity claims are distinguished. According to Habermas, every communicative utterance simultaneously raises a claim to truth, a claim to normative rightness, and a claim to truthfulness. These claims refer to three different worlds (the object world, the social world, and the subject world, respectively), and hence should not be mixed up, as they often are in premodern societies. Nor should they be reduced to one, as in modern positivist thinking, where only the claim to truth is recognized. Such a reduction means in effect that everything is considered an object, including the human subject and normative grounds.

However, there is also a second process of rationalization that has been described by Max Weber as well, but which Habermas distinguishes sharply from the first process. Simultaneously with the advance in communicative rationalization, there also occurs an advance in the rationality of the society as measured from a functionalist or systems perspective. This means that there is an expansion of social subsystems that coordinate action through other means, namely, through the media of money (the market) and administrative power (the bureaucracy, or the centralized state). This rationalization process is ambivalent. It is beneficial to the extent that it releases the (growing) pressure on communicative action. Communicative action is rational, but also costly; it typically takes a lot of time to reach agreement in a group. The other coordination mechanisms are much more efficient. But the problem that Habermas notices is that these other coordination mechanisms increasingly invade *all* the areas of social life. This is called the "colonization of the lifeworld" that brings in its wake a growing sense of meaninglessness and dwindling freedom.

It is not the place here to enter a philosophical discussion on the differences between Heidegger and Habermas. A few short remarks must suffice. Habermas follows Heidegger in his critique of Western rationality, and for both philosophers this is related to a different view of "language". But whereas in Heidegger's (later) thinking, the human subject gradually disappears under the massive weight of Language and Being, the human responsible subject is central in Habermas' views. For Heidegger, truth is an anonymous process of unconcealment (cf. [20] p179), whereas for Habermas, it is a claim made by a speaker that he should defend against counter-arguments.

3.2 Rationalization and automation

Let us now come to the question whether formalization (and automation) of communication processes is something to be pursued. The answer to this question depends heavily on the question what kind of rationalization is at stake here:

- is it a form of rationalization of the lifeworld, in which the level of communicative rationality is raised?
- is it a form of functional rationalization in which communicative action is replaced by something more efficient?
- is it a form of functional rationalization that threatens the lifeworld (its rationality and solidarity)

The preliminary answer that we want to give in this paper is it can be any of these three, depending on the kind of application and the context in which the application is used. In the next section, we will describe different applications and come back to this fundamental question with each of them.

To enable us to at least consider the possibility that automation is a form of functional rationalization, we want to extend the framework of Habermas in the sense that besides market and the bureaucracy also technology is considered as a (modern) coordination mechanism. Just like the other mechanisms, it increases efficiency and effectivity by shortcutting processes of mutual understanding. Admittedly, it is also possible that the technology is just a way of implementing a market or a bureaucracy, as in the case where we speak of electronic markets. When we suggest that technology is a third coordination mechanism in its own right, we mean those kinds of applications that cannot be interpreted as either market or bureaucracy.

3.3 Refining the concept of communicative action

In the following, we will also need a refinement of the concept of communicative action. Communicative action has two aspects: it consists of actions towards mutual understanding (*Verständigung*), and its goal is the coordination of the actions of the participants. One could ask whether these two aspects go necessarily together. Now Habermas also discusses consensual action and conversational action as special kinds of communicative action (borderline cases) ([11]).

In the case of consensual action, interaction takes place on the basis of an already achieved common definition of the situation [13]. This means that actions towards mutual understanding are no longer necessary, and what remains is only the coordination. An example is the communication in a surgery team. The communication can be kept short, and, as long as no exceptions occur (that are avoided as much as possible, of course), there is no process of *Verständigung*.

Conversational action is just the opposite. In this kind of communicative action, the emphasis is on mutual understanding, and there is no (or less) urgency to coordinate actions. A typical case of conversational action is the informal talk that people have in the coffee corner. If its purpose is not to coordinate actions, one could question its utility. However, it can be argued that these kind of conversations do have a purpose in that they contribute to common definitions of situations. These situations may have a hypothetical character during the conversation, but they could become real later.

Taking all this together, we distinguish the following types of action:

- conversational action as informal communications that feeds the shared knowledge of the organization
- communicative action as the more formal (but still covering the whole spectrum of natural language) communication that is oriented at coordination. This kind of communication may draw partly on the pool of shared knowledge feeded by conversations.
- consensual action in which a reduced and perhaps formalized language is used with the goal of coordination. This is only possible against a background of communicative action
- non-communicative action as coordination by means of money, bureaucracy or technology.

Note that these types of actions also relate strongly to the situations of communication distinguished in the introduction. The inter-human communication pertains mainly to the conversational and communicative actions. The situation of communication support relates strongly to the consensual actions. And the system to system communication can be seen as non-communicative action (human communication replaced by technology).

4 Organizational computing: some examples

In this section we want to take a closer look at some application types in organizational computing that involve communication. For each example we will show which type of communicative action is involved and whether formalization for this type of application is useful (or even necessary).

4.1 Meeting support

The applications that are concerned with support of meetings are electronic meeting rooms, research networks, etc. Meetings can be synchronous and asynchronous, and taking place at one location or over a distance. In the following, we will concentrate on electronic meeting rooms where the participants are together in the same room at the same time, although most conclusions will apply to the other cases as well. A well-known tool for EMR support is GroupSystems [15]. An EMR system does not try to replace the communication with technological means, but to provide support. An example is a brainstorming tool that allows parallel and anonymous input, and then presents the results to the group for discussion. This can speed up the idea generation and can also take away social obstacles for participation.

However, the basic motivation for the use of EMR tools in group meetings is not the increase of efficiency, but the minimization of productivity losses. The tendency for groups to become less productive as group size increases is known in the social sciences as the Ringelmann effect [7]. It has also been attested in numerous experiments that in terms of creativity, groups perform lower than the best member. Argyris has pointed out that people are often unaware of their defensive, and ineffective behaviour in groups [1]. The question then becomes how meetings can be conducted in such a way that these undesirable effects are minimized and the result is satisfactory rather than frustrating. Measures that can be taken range from good facilitation, the adoption of effective decision procedures, thorough preparation, increasing awareness of one's behaviour (reflection) to the use of automatic tools to support some specific aspect or component. What is most important is not the tool, but a more conscious use of communicative actions. In line with Habermas, we can call this a rationalization process (of our lifeworld).

Although group meetings are often ineffective, it would not be a good idea to dismiss them completely. Meetings are a kind of communicative action that play an important role in coordinating the individual behaviours. Since it is through language that we give meaning to the world we live in and share with others [20] p78, we do need meetings in which speaking as well as active listening can create new (shared) spaces of possibilities. Participation, perhaps with the help of a coach, can also be an instrument in learning, in altering one person's interpretative framework [3].

What kind of rationalization is useful in group meetings? Without trying to be complete, we want to discuss the following points:

1. identifiability and responsibility
2. transparency of commitments
3. transparency of validity claims
4. transparency of conversation type / meeting goals
5. transparency of authorizations

Identifiability

Forsyth gives a couple of suggestions to avoid productivity losses in groups, such as involvement, mutual trust, personal responsibility and identifiability. Identifiability means that each member's contribution to the group project can be clearly identified. More precisely, it is not the identifiability per se but rather the possibility of evaluation that is the key to controlling social loafing.

Evaluation can be considered an aspect of rationalization, because it means that subjects are identified and recognized as subjects, rather than being objectified and reduced to instruments. Of course, the other extreme should be avoided as well, where the only goal is to promote one's own personality. This would be a reduction to the expressive aspect of communication.

Transparency of conversation type

Janson and Woo [10] compared different IS development methods from a speech act perspective. By looking at the kind of speech acts made by different participants - users versus analysts -, one can detect different conversation types underlying the user-analyst meetings. In JSD, the users describe the application to the analyst; the analyst may ask questions for clarification, and finally the analyst writes down the specifications. In SADT, the modelling technique that is used stimulates exploring the application domain in more depth. This can only be done by the users. Hence the conversations contain more commissives from the users (to investigate unsolved issues) and also directives to the analyst for clarification on the method.

The fundamental difference between the two methods, JSD and SADT, seems to be that in the former, the analyst is responsible for building the specifications, and the user is supposed to describe the domain of application, whereas in the latter, the user is responsible for building the specifications. The former can be described as a factagenic conversation from user to analyst, whereas the latter is a actagenic conversation from analyst to user and a factagenic conversation from user to analyst (thus making up a complete transaction, or conversation for action).

Evidently, a design meeting can be structured in different ways, leading to different conversation types. Transparency of the goals - who is responsible for what - will increase the transparency of the conversation type. When the participants are made aware of this, it may reduce the number of counter-productive moves.

Transparency of commitments

Quoting Winograd and Flores, Bennett emphasizes that "to be human is to be a kind of being that generates commitment, through speaking and listening" [3]. Commitments are not always clear. Rationalization of the meeting means, for one thing, that requests for commitments are transparent as well as the commitments of the responsible actor. The last thing can be achieved, for instance, by putting a commitment on the "to do" list (published with the minutes of the meeting) only after consent of the responsible actor. Whether the transparency of the requests and commitments is supported by a tool, such as the Coordinator, or by linguistic means (the use of explicit speech act verbs), is less relevant than the transparency itself.

Transparency of authorizations

When people make requests to other people, there may be different claims with respect to the validity of the request. In [5], we distinguished charity, authorization and power. The most secure is authorization, since power is not based on rationality and charity depends on the goodwill of the Addressee. Transparency of authorization means that the requests made to participants during the meeting, are clearly authorized requests.

How is it possible to make authorized requests? Only by having asked for authorization at some point, during the meeting or before the meeting. Rationalization of the meeting thus includes that authorizations are not taken for granted, but asked explicitly. This point is stressed also by Bennett when he draws attention to "asking permission", for example, in the form of a prior "partnership" between participants. Such a partnership can enable "collaborative coaching", by means of which people can learn to recognize dysfunctional behaviour. This is a special case, since authorizations can apply to all kinds of actions, not just interventions.

Transparency of validity claims

For Habermas, rationalization of the lifeworld includes the distinction between different validity claims. When a speaker makes a communicative action, he typically makes several validity claims simultaneously: that the statement is true with respect to reality, that the action is legitimate with respect to the norms of the social world, and that he is sincere. We are not aware of an existing tool that supports making these distinctions, but such a tool could certainly help in avoiding useless argumentations where these validity claims are mixed up.

For Habermas, rationality also means that the participants are able to back up the validity claims that they raise. A method that supports structuring argumentations is IBIS and a tool that supports this method is gIBIS [9]. Such a tool could be extended so that normative, cognitive and expressive validity claims are clearly distinguished.

Summarizing, we conclude that group meetings can be considered as communicative action, and that there are several possibilities for rationalization. This will lead to a certain kind of formalization, for example, when a "to do" list is maintained, but this is formalization of the communication processes themselves, and not meant to replace communicative action.

4.2 Workflow Management

Traditional workflow management systems can be seen as a form of bureaucracy (cf [12]). They support the coordination of activities through technological means. The main emphasis of these products lays on the logistic aspects of the workflow. A workflow is depicted in a similar way as the production process in a factory.

The consequence of seeing the workflow as an autonomous process in which the persons are used as resources is that explicit coordination between persons becomes superfluous. The coordination between the persons follows from their respective positions in the workflow.

What are the consequences of this viewpoint for the concepts of responsibility, commitment and authorization?

The responsibility for a particular case in the workflow can hardly be attributed to one person any more. Each person in the workflow is responsible for a small part of handling the case. Although this might be a positive development for reasons of communication efficiency it also makes it more difficult to deal with "breakdowns". It is now a problem to decide which person should take action to handle the breakdown because noone is responsible anymore.

The commitments given in the workflow are completely implicit. The workflow determines the actions of the persons. Therefore they are committed to perform an action by the fact that they receive the case at a certain time. The need to give explicit commitments is therefore absent.

The authorizations are determined completely through the organizational structure in which the persons function. Thus also authorizations do not have to be given explicitly anymore.

The use of this type of workflow systems is limited to the cases where the activities of the organization are highly repetitive and very structured. In this situation the coordination of the activities can be determined largely through the organization structure ("bureaucracy", in terms of Habermas) and communication can be replaced by technology.

There is one workflow system that deviates markedly from the traditional workflow systems: Action Workflow [14]. Action Workflow use the Language/Action paradigm as starting point to describe the coordination of activities within an organization. The main purpose of this tool is to make the commitments that persons make towards each other in an organization visible. By monitoring these commitments it is possible to enhance the efficiency of the workflow (on a more essential level than done in the logistic systems).

Instead of replacing the communication in the workflow by organizational structure and technology Action Workflow concentrates on the consensual communication in an organization as being of prime importance for the primary process. The physical workflow is modeled through the communication that directs this workflow. The communication loops that form the basis for the workflows in Action Workflow consist of four phases:

1. Proposal

2. Agreement
3. Performance
4. Satisfaction

The first two phases indicate the transfer of a case from one person in the organization to the next. The third phase (Performance) signifies the assertion of the performer of the physical action that she has actually performed the action.

It may be clear that these communication loops are excellent means to capture responsibility, commitments and authorizations. Like the tools for meeting support, Action Workflow rationalizes the workflow through supporting the rules of commitment that underlay the workflow. This contrasts with the approach of other workflow systems that rationalize the workflow through formalizing it and fixing the structure of the workflow through the process structure and organization structure.

The four phases of the communication loops of Action Workflow are not defined formally. They can consist of many messages or can be implicit in some action. Each phase in the loop is supported, however, by giving the information needed to complete that phase, triggering actions and sending reminders.

Of course, if the phases can be described formally, more (relevant) information can be presented at the right moment. However, the power of the present approach is that the phases can be more or less formalized and depending on this more or less support can be generated.

It seems to prove the point that to support communicative action one should not try to formalize these actions in a rigid manner. One of the characteristics of communicative action is that it can be used to react to unsuspected circumstances which needs a high degree of flexibility, which in its turn does not go very well with a rigid formalism.

4.3 Software agents

The last example we would like to discuss are the so-called software agents. Many papers on agents start with stating that there is no unique definition of the term agents, after which they give (yet another) definition of the term themselves. Here we consider agents to be all those programs that are perceived as agents. One important feature of all software agents seems to be a certain kind of "autonomy". I.e. the programs run for an extended period of time without interference of the person that started the program. The program reacts to events from the environment and can report back to the user or start up other programs.

For our purpose the software agents only become interesting when several agents coordinate their actions. I.e. an agent gets a task which it distributes to one or more other agents. In such an environment some type of "communication" between the agents is necessary. The type of communication that is supported between agents is usually very limited because it is mainly seen as the transfer of information instead of seeing it as an action in itself. This limitation on the communication permits its use only in highly structured environments.

One should not confuse this with the idea that agents operate in complex and unstructured environments like the WWW and Internet. Although a software agent might work within the WWW environment it only reacts to a limited number of impulses from this environment. One of the proclaimed advantages of using (simple) agents in these environments is that one can let each agent(type) react to a different part of the environment. In this way the complexity of the environment is divided among the agents.

In recent years it was recognized that the coordination of tasks between agents is more than the transfer of information. Some effort has begun to define agent communication languages based on speech acts. The most well-known language is KQML [6]. Although this language is based on speech acts it is not based on the Language/Action Perspective. Although many performatives are incorporated in KQML the pre- and postconditions of the messages are unclear and certainly not equal to the ones in human communication.

It is clear that the communication between agents should be completely formalized. Any communication between formal systems should itself be formally defined, otherwise the systems could not react (appropriately) to a message. Another question is which concepts should be involved in the

formalization of this type of communication. This depends (completely) on the role of the type of agents that are involved. Agents can be used to fulfill many different roles. They can be used to replace non-communicative action, for support of consensual action, for support of communicative action, but also for the simulation of (parts of) these types of action.

In case the agents are used as a technology to replace non-communicative action, this action should be completely formalized. Usually this only occurs in highly structured environments, because the structure of the environment prevents the need of a very advanced communication mechanism. There is no need to introduce concepts such as goals, authorization etc. in the agent formalization, because they are fixed in the environment of the agents. We consider this kind of non-communicative coordination different from "bureaucracy", since the agents are installed by the human subjects themselves.

Another place where agents are used is in the support and replacement of consensual action. A good example for this area is electronic commerce. In this area the agents can autonomously "negotiate" with other agents. This can only be done when the negotiation protocols are simple and fixed. In order to support or replace more complex negotiation also more concepts are needed in the formalization of the pre- and postconditions of the communication. If the agent acts as a representative of its user it should also "know" about the goals and authorizations of its user in order to determine its possible communication moves.

A third way that agents are used is as personal assistants. In this role they are supposed to function as a partner to their users. The communication of these agents should replace communicative actions that the user would otherwise have with other users. In order for this communication to be natural one should formalize many concepts related to the motivational attitude of humans. However, one should not confuse these formalized motivational attitudes with actual human attitudes. E.g. an agent can maybe formally represent the concept of commitment, but in our view this attitude can only be ascribed to humans.

The last role that we want to mention here, although it plays no part in organizational computing, is that of simulation. Agents are used in many areas to simulate human behaviour. In this role as much as possible should be formalized in order to make a proper study of the simulated situations possible.

To conclude this section it can be said that formalization of the communication involving agents is always necessary (because they are formal systems). The type of concepts that should be included in the formalization depend on the type of role that the agents play (which type of action they replace). Although many concepts should be included to make the agents flexible and adaptive in complex environments, one should not confuse these formalizations with the actual attitudes ascribed to humans. In specific it is useful to include formalizations of goals, commitments, responsibility and authorizations in agents, but these attitudes can never be ascribed to the agents. (They might be ascribed to their users though.)

5 Conclusion

Is formalization of communication useful? And if so, how far should one go? In the preceding sections we have shown that the answer to this question depends on the type of communication that is modeled and also the purpose of the formalization (what type of rationalization is intended). In general we agree with Winograd and Flores that it will not be possible to formalize all human communication. However, a limited form of formalization of communication is useful if we want to support the rationalization of the communication process, like in meeting support and computer supported cooperative work. As remarked earlier in section 3.1. modern culture forces a rationalization of the communication through the deterioration of traditional power structures that can be used to justify communication. Therefore it seems that the formalization of the communication process for this rationalization purposes is useful and indeed preferred.

Also when communication is replaced by something more efficient, as it is the case in applying workflow management systems or software agents, it is important to have some formalization of the communication. At least one should know what part of the human communication is replaced through the automation and what are the consequences. If one agrees with Habermas that the high pressure on communicative action necessitates the use of non-communicative coordination mechanisms, the

question remains only how far one should go with this replacement. The best strategy seems to be to develop non-communicative coordination mechanisms where necessary, but always embed them in a communicative domain where human responsibility can be maintained. So, for organizations, a system like Action Workflow can be applied fruitfully, but it should not totally replace the communicative action such as it can occur in meetings; and the latter can not do, in the end, without the backing of conversational action domains in the informal communication. A similar argument can be made for interorganizational communication, such as Electronic Commerce. Non-communicative coordination (e.g. by means of software agents, operating on electronic markets) can only be effective in very specialized and structured domains. In other domains, they can only be applied if there are supporting communicative coordination mechanisms as well, for example, in the form of "network organizations" or "virtual organizations".

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