Computers and knowledge: a dialogical approach.

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Computers and Knowledge: A Dialogical Approach

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Abstract

Artificial intelligence researchers interested in knowledge and in designing and implementing digitized artifacts for representing or sharing knowledge play a crucial role in the development of a knowledge-based economy. They help answer the question of how the computer devices they develop can be appropriated by the collectives that manage the flow of knowledge and know-how underlying human organizations. A dialogical, constructivist view of interaction processes permits theorizing the role of digital tools, seen as sociotechnical devices that serve both as resources and as sources of communication within our organizations.

Key Words

Cognitive Artifact, Dialogism, Intercomprehension, Situated and Distributed Cognition, Knowledge

Introduction

Knowledge production in human groups is relying more and more heavily on computer-based devices (CBD). Such devices are often seen as a medium for coding knowledge and exchanging information. They serve as resources for collective activity, in the sense that they improve our ability to manipulate data, speed up information exchange, and supply decision-making aids. However, CBDs cannot be reduced to their function as a communication medium. Indeed, an interesting aspect of these digital objects, these artifacts or products of human design, is that they also perform a cognitive function for collectives. They take part

in creating and defining the space within which actors collaborate. The way humans use them to compose messages, write scenarios, and formalize procedures affects how their users will express their thoughts. The way they are utilized by small groups to communicate, make choices, and formulate a group decision affects how those groups will take action and put into effect what they are planning. In other words, computer-based devices in some sense "configure" collective cognitive processes. As such, these artifacts act not only as resources (they support human activity), but also as sources of that activity (they define its configuration).

While the first of these two functionalities of computer devices -- their role as information-communicating resources -- is widely acknowledged, the second is far less so. Or in any case, it does not come immediately to the minds of individuals who design computers, software, or groupware, most likely because this type of instrumentation is regarded first and foremost as a tool that leaves intact and untouched what it serves to exchange, transport, or codify. Stated differently, computer machinery is often seen as a mere medium or means of manipulating information. This is fully conceivable as long as one takes an informationalist view of the communication process, but it becomes inadequate as soon as one approaches the process from a dialogical and constructivist angle. If communication is a joint meaning-building dynamic based not only on the chaining of utterances, but also on microgesturality and the use of the objects that constitute the interaction arena, then computer-based devices -- which, precisely, are more and more frequently located at the center of that arena -- must be ranked among the entities that determine the semiotic value of the interactants' productions.

The aim of this paper is to establish the theoretical and concrete bases for defending this idea. I will do this from the viewpoint of my position as a social psychologist of collaborative cognition processes, one of whose methods is to analyze interactions between humans. The first part (**1. Communication: Exchanging Information *versus* Joint Construction of Meaning**) begins by describing the shift from an informationist view of communication to a dialogical and constructivist view, before going on to show how adopting the latter point of view leads me to include this approach in the paradigm of situated and distributed cognition (**2. Dialogism and Situated and Distributed Cognition**). Then the various consequences of this view on the link between the (calculatory) manipulation of information (by the CBD) and the (cognitive) mobilization of knowledge (by human groups) will be addressed. This will bring us to the issue of knowledge digitization (**3. Digitization of Knowledge: A Design-Use Dialectic**), which will be approached in relation to concrete situations where CBDs are designed and used. Before concluding, the potential implications of this type of approach on our understanding of knowledge management within human organizations will be discussed (**4. Digitized Artifacts and Knowledge Management**).

1. Communication: Exchanging Information *versus* Joint Construction of Meaning

The informationalist approach to communication is now widely challenged. It fades into the background in the face of the idea that social interaction is the locus of a meaning-negotiation or joint meaning-building process (Bruner, 1990/1991), of the intercommunicability of cognitions. Both Bakhtine (1929/1977) and Jacques (1985) worked extensively on this *dialogism*, which is found throughout all human discursive productions, whether oral or written, whether within a monologue or dialogue. Their idea was to theorize the fact that what comes logically first in any communicational event is the speaker's relationship to the other person (by way of the addressed character of discourse for the former author, and *via* the primacy of the relationship for the latter).

Jacques approaches the issue by speaking of communicability and rejecting communicativity (1985, 2000). Communicativity pertains to the egocentric perspective that characterizes language-based approaches to communication, while communicability pertains to the relationship-centered perspective to which Jacques adheres. This being said, it is clear that this way of thematizing the issue focuses on the language dimension of communication. It is a question of verbal, face-to-face interaction, a dialogue, a conversation in the broad sense of the term meaning a chain of utterances produced in an interactive situation.

Employing the words of a social psychologist to refer to joint cognitive processes, I will attempt to describe the shift from communicativity to communicability, i.e., from a view of communication as an exchange of information to a view that approaches it as a joint meaning-construction space. The focus will be on the mechanism of intercomprehension, seen as a four-stage process. This will lead me to place this approach in the paradigm of situated and distributed cognition. Below is a brief presentation of the four stages developed in this section.

1. Intercomprehension is a key mechanism of conversation; modeling it is one of the tasks of discourse analysts.

2. Intercomprehension is widely regarded as a process wherein mental states are fit to each other (A and B understand each other if A understands what B means, and vice versa).

3. But intercomprehension can also be seen as a joint construction process (A and B understand each other if they are co-responsible for the generation of meaning).

4. The cognitivist (or more generally representationist) paradigm serves as a background for intercomprehension as a process of *fitting mental states*, whereas the constructivist paradigm (one could also say enactionist) serves as a background for intercomprehension as a process of *generating semiotic dynamics*.

1.1 Intercomprehension ...

In addition to the fine-grained description of conversational dynamics, a task of all discourse analysts is to model the mechanisms that link utterances together to form a conversational chain. Regardless of whether they rely on speech act theory (Searle & Vanderveken, 1985; Vanderveken, 1988, 1990), all discourse analysts attempt to grasp the subtle interplay of utterance productions-interpretations that builds the framework of the temporal event constituted by any language-mediated exchange (Roulet *et al.*, 1985; Bange, 1987, 1992; Cosnier & Kerbrat-Orecchioni, 1987). And regardless of whether they look for regularities or rules in these discursive creations, they are necessarily faced with a very simple question: How do interacting individuals understand each other? This core question forces us to think about the higher processes that allow us to express cognitions and grasp semiotic forms. Now wondering how two humans understand each other obviously does not imply disregarding cases where disagreements lead to communication failures. Intercomprehension must of course be seen as a broad category that encompasses the negotiation of meaning and the management of cognitive conflict (not necessarily resolutory), and in which a meaning-negotiation process is generated by the conversational history (Ghiglione & Trognon, 1993). Intercomprehension therefore means more than just arriving at a *consensuality*, even local; it has a more general meaning of being capable (at least temporarily) of perpetuating a *consensibility* (according to the subtle distinction proposed by Ziman (1991) and taken up by Nowotny *et al.* (2001/2003: 218 *and sq.*)). We are now in a position to consider

intercomprehension -- the intersubjective phenomenon that it truly is -- from the angle of two, clearly distinct paradigms.

1.2 ... as a Mental-State Fitting Process

An extremely widespread idea is that a conversing speaker talks with the intention of *getting something across*, and that the listener processes that utterance in order to uncover/recover that "something". Briefly, according to this theory, the speaker has a clear and precise idea that he puts into words; these physically transported words are subject to processing by the listener, who processes what he hears. A consequence of this theory is that if no one makes any "stupid" mistakes, and if no information is lost during the transmission process, the final idea will (ideally) be the same as the initial one; communication is perfect. In other words, the processing of what a speaker says is an operation whose output is an object that existed before the processing took place, namely, the meaning intended by the speaker. One cannot get around this view of things by being Gricean (Grice, 1979) or by being an advocate of Sperber and Wilson's relevance theory (1985).

The mechanism is as follows:
- The speaker has a certain communicative intention.
- He produces a meaningful utterance.
- The listener perceives the utterance and *processes* it.
- After processing it, the listener *retrieves*, *finds*, *accesses* the intended meaning.

The processing is correct when a given relationship exists (hopefully identity) between the intended meaning and the discovered meaning. Regardless of how the utterance is processed, this way of seeing things places the speaker's intended meaning -- which exists prior to being interpreted (one could also say read, decoded, deciphered, etc.) by the listener -- is at the crux of the intercomprehension process. The distinction between communicativity and communicability is critical at this point. The approach just presented is included in the communicativity paradigm. Even if more is at stake than just transmission, the intercomprehension process we are dealing with is viewed as a sequence of asynchronous and asymmetrical production-interpretation pairs. The speaker is the proprietor of a meaning, whether explicit or implicit, and the listener's task is to discover it before he in turn becomes the proprietor responsible for its interpretation, whose linguistic trace he produces and which then becomes the processed object. This is a chain of individual cognitive mechanisms. Intercomprehension is the process of adequation between the personal cognitions of the interactants.

1.3 ... as a Joint Meaning-Construction Process

The suffix of the alternative term proposed by Jacques (communicability) leaves room for the *possible*. When a speaker proffers an utterance, there is not *one* meaning that is communicated; the utterance produced is simply a bearer of a set of possible meanings. The exchange unfolds around the actualization of one possibility in this set of possibilities. The actualization is brought about by the dyad; it is the joint output of the interactants. Let us illustrate with the following conversational excerpt (already presented in Brassac, 2001):[1]

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[1] Proposed by Jean-Louis Dessalles at the 1995 Cognitive Research Association summer school held in Bonas, France.

t_0	S1	Oh this is funny! I have this exact painting at home; it's the same size; it depicts the same thing.
t_1	L1	It's yours. Maybe someone stole it from you.
t_2	S2	No mine's darker; it's more beautiful.

Here, quite clearly, is what I would like to show:

    a. S1 is a linguistic form, a bearer of a set of possible meanings.

    b. L1 is a proposed actualization of one of the elements in that set.

    c. The pair (S2, (S1 ← L1)) is the position the two interactants take regarding the proposed actualization. This position is negotiable.

    d. If there is a meaning, it is still up in the air at t3, for example, when L2 will be uttered.

a. It is clear that speaker S expresses *something* in verbal format. Utterance S1 is a linguistic form that conveys meaning. We cannot state here that it is an assertion, an expression of regret, a worry, a question, or any other particular speech act. We can simply say that this utterance is capable of conveying all of this, and perhaps other things that we, as analysts, *do not see*. The issue here is certainly not about choosing one of these possibilities.

b. By uttering L1, L proposes to actualize one of the potential meanings. The meaning in question is the one we could call the word-for-word meaning. In saying "Oh this is funny", "this", and "exact", S expresses his surprise that his painting is there in front of him, in the store window. What allows us to say this? ... the fact that L offers an explanation for S's surprise: "It's yours. Maybe someone stole it from you". He satisfies the preparatory conditions for the expressive speech act of surprise.

c. In uttering S2, S invalidates this proposed meaning by offering up an additional element, his tone of voice, proving that *this* particular painting is not his. In effect, he is telling his interlocutor not to take what he said literally. The function of the pair (S2, (S1 ← L1)) in this case is to postpone the cognition-fitting mechanism.

d. At that moment, an observer absolutely could not say something like: S meant this, L didn't understand him. The process is not finished, and its outcome (if it exists) is still undetermined; it is negotiable and will perhaps be negotiated.

Because this excerpt is limited to three speaking turns, we do not *know* whether this intercomprehension phenomenon will be resolved and stabilize on the meaning at stake here. Whatever the case may be, I would like to make the following point: an interlocution generates a flow of meanings that may lead to misunderstanding and may be marked by total indetermination. In no sense is this indetermination an obstacle to intercomprehension. It is precisely because the process produces indetermination that it permits the intercommunicability of cognitions. All a conversation needs to keep going is the possibility of a simple, transient understanding. It is even actualized on that transience. An interesting case in point is the one where the interlocutors realize mutually that they have been *riding on* a misunderstanding, which leads to a break in the linearity of the communication process. Far from being the sign of a failure, such an event is in fact the mark of successful communication. Indeed, realizing that you thought you were understanding each other but were mistaken, signals *in an overt way* that real, albeit imperfect, communication is nevertheless taking place. In other words, if S wants to (intends to) communicate a cognition, its linguistic expression, S1, is capable of permitting that to happen; the cognition in question is communicable, even if it is not communicated. But S may very well

settle for not being understood as long as his interlocutor cooperates in a joint construction process. The important thing is communicability, not communicativity.

Grounded on the essential idea that meaning is co-constructed in a process-based, radically dialogical fashion, this way of modelling conversation draws from a constructivist perspective. There is no need to postulate a preexisting meaning, one that exists before the linguistic form proffered in context is expressed and understood. It suffices to accept the simple idea that interactants immersed in a subtly impermanent set of potential meanings jointly shape this potential in a process-based way that makes a tentative and still-negotiable meaning emerge from it. Here, intercomprehension is this intersubjective cooperation process.

1.4 Communication, Cognitivism, Constructivism

The difference between these two ways of understanding intercomprehension can be expressed in terms of representations. More precisely, I propose to go along with Havelange *et al.* (2002), who make the careful distinction between two senses of the term "representation": (i) the result of being *re-presented*, and (ii) the dynamics of *rendering present*. It is clear that in both views of intercomprehension evoked here, the interactants "work on" the successive utterances produced.

In the first sense, the utterance is an entity that results from putting a cognition into words, the cognition itself being a re-presentation of the world. Re-presentation is written with a hyphen because a mental state presents *again*, in the mind, some part of the world. Proffered by the speaker and thus offered up for hearing, the utterance becomes a sort of piece of information among the many that populate the listener's world. The listener then works on the information (the utterance) by "processing" it in the purest sense of the term used in classical cognitivism (note that this thesis is taken to its paroxysm by Sperber and Wilson, 1985). The output of the processing taking place in the listener's head leads to the next utterance, for which he is responsible and which, like the information available in the world, is subjected to processing by the new listener (the initial speaker). A meaning-negotiation process has been triggered; it is brought about by the succession of information-processing operations, generators of mental states. Intercomprehension can be attained by interrelating the mental states of the two interactants. This view of the conversational chaining process is based on classical cognitivism, so it is *re-presentationist*. The analysis method is interactionist, granted, but the building block is the utterance, by virtue of its status as the object of a production and of an interpretation, two mental processes.

In the second sense, the processing is truly a joint effort, in that the expression and apprehension of the linguistic forms uttered are the outcome of a "making present" process. When Maturana and Varela proposed the concept of enaction, it was to attack the internalism described above (Maturana & Varela, 1994; Varela, 1989, Varela *et al.*, 1993). In their view, cognition is not information processing at all, but an incorporated action that takes place within a so-called second-order structural coupling between the knowing entity and the world. Havelange *et al.*'s proposal is very elucidating in this respect (2002). They propose to thematize representation as a dynamic that renders present the world in which an action is occurring.[2] The utterances we are interested in here, the ones that constitute a dimension of the thread of the conversation, are an integral part of the interactants' world. They obviously fall within the scope of enaction theory. The listener, *via* the perception he has of this forms, acts

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[2] For a review, see the highly interesting paper by Lassègue and Visetti (2002).

concomitantly upon it, rendering it present, giving it a semiotic status, granting it a communicative potential. We are indeed dealing with a potential here, for the speaker is clearly his own listener and as such is in a similar position with respect to what he himself is saying. Far from *translating* what the speaker wants to say, an utterance can be worked upon by its own producer, who thereby participates fully in the semiotic construction. This joint work -- which Maturana and Varela called the third-order structural coupling (1994, Chapter 9) although without proposing a convincing model of it -- takes place during the ensuing negotiation. The coupling is not a succession of mental states, but a dynamic, an interactive history, an ongoing genesis that gradually shapes the forms and assigns them semiotic values. The shaping process relies on the interactants' bodies (not just on their central nervous systems) and also on the material objects[3] that make up the conversational arena. This view of conversational dynamics is rooted in constructivism (which could have deserved the name "enactionism"), and is consequently *render-presentationist*. The analysis method is interactionist in the strong sense of the term, insofar as the relationship between the interactants governs the engagement of the semiotic value-building process carried out on potentially meaning-bearing utterances.

The opposition between the two views of intercomprehension is found again in the re-present/render-present opposition. In cognitivist terms, meanings are communicated *via* the utterances that encapsulate them. In communicativity, the interlocutors' brains come first; they contain the mental states and their articulation with each other is based on an interactional computation. In enactionist terms, meanings are co-constructed *via* a joint action within a coupling between the conversing bodies in their relationship to the linguistic forms produced. In communicability, these forms (the utterances) are the bearers of meanings whose emergence throughout the history of the conversation is governed by the relationship.

2. Dialogism and Situated and Distributed Cognition

It remains nonetheless that this way of theorizing communicability confines us to a study of interaction keyed on language. I will attempt to propose a more integrative approach to interactive phenomena, an approach based on communicability, granted, but one that expands the study of intersubjective processes to nonlinguistic forms.

2.1 Dialogism and Psychology

In my contribution to a model of conversational chaining (Brassac, 1992; Trognon & Brassac, 1992), I supported the idea that meaning is co-constructed as the conversation proceeds, the co-construction process seemingly being rooted in the intercommunicability of cognitions. I would like to express my partial dissatisfaction[4] with this model because of its inability to account for two phenomena: (i) the fact that in dialogue (two-person dialogue), the speaker always has two listeners (the person he is talking to and himself!), and (ii) the fact that as the conversation progresses, a meaning not premeditated by the speaker can be actualized by the interacting pair (which includes the speaker himself!). As a result, in pursuing the comparison of these two views of

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[3] I will return to this point in detail later.

[4] I still believe in the importance of an action-based dynamic, a retroactive construction process, but I am more doubtful about its logicalization and its representationist background.

intercomprehension, we are led to reflect upon the relationship between the initial speaker and the set of potential meanings. There are two possibilities: either the speaker checks what he just said to see what it might mean, or he does not. In both cases, of course, we would all agree that he meant something, but what about how he relates to what *becomes* of what he said? Let us state this in simple terms. Not only may the speaker be surprised by what he said, he may be surprised by what the listener might have heard in what he said. In other words, we must take into account the fact that the speaker may discover (by himself or through the other person) a non-premeditated aspect of the verbal material he employed to signify something. I argue that the conversational discourse analyst cannot ignore these intersubjective phenomena.

Mead, Vygotski, and Bakhtine are very useful for reformulating these remarks[5] in a more scholarly way. As the founder of symbolic interactionism and recognized accordingly as a major source of inspiration in social psychology, Mead tells us this: "It is only after we have said the word we are saying that we recognize ourselves as the person that has said it, as this particular self that says this particular thing; it is only after we have done the thing that we are going to do that we are aware of what we are doing. (...) It is only after the act has taken place that we can catch it in our memory and place it in terms of what we have done (Mead, 1934/1967: 203). Taken from his critical work entitled *Mind, Self and Society from the Standpoint of a Social Behaviorist*, this quotation is very elucidating for our purposes here. It is unfortunately not characteristic of interaction psychologists, who, as social psychologists, tend to forget the reflexiveness of human expression. This is probably because this work is under-read in our field[6], unlike Vygotski's which is so well-received (Schneuwly & Bronckart, 1985; Moro *et al.*, 1997; Bronckart, 1997; Rivière, 1990; and more recently Clot, 1999a, 1999c). On the other hand, the following quotation is quite well known: "The relation of thought to word is not a thing but a process, a continual movement back and forth from thought to word and from word to thought. (...) Thought is not merely expressed in words; it comes into existence through them. (...). It does not merely find expression in speech; it finds its reality and form" (Vygotski, 1934/1985: 71-73, our translation), as is this even more precise one: "Thought is not expressed in the word but is realized in the word. That is why we can speak of thought becoming word. (...) This unfolding of thought takes place in the form (...) of a transition from thought to word and from word to thought" (*ibid*: 329, our translation). This radical dialectic, stressed by the Soviet author, helps us grasp the idea that the production of an utterance leaves room for surprise[7] on the part of the speaker intending to mean something within a given interaction. And Bakhtine was saying the same thing when he wrote, "It is not the mental activity that organizes the expression, but on the contrary,

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[5] The ideas in this part are developed in detail in Brassac (2003).

[6] A few leads can be found in Brassac (2003a), but there is a great deal of ground to cover if we want to take a new look at Mead's intuitions about communication, the heart of the social order. "Social psychology has, as a rule, dealt with various phases of social experience from the psychological standpoint of individual experience. The point of approach which I wish to suggest is that of dealing with experience from the standpoint of society, at least from the standpoint of *communication as essential to the social order* (Mead, 1934/1967: 1; my underlining).

[7] "And then came out of my mouth a surprising, unexplainable sentence for which I still feel barely responsible" (J. Gracq, *Un beau ténébreux*, p. 38; our translation); "It is indeed he who pronounced these words, they came out of his mouth, and yet they surprised him" (J.-M. Coetzee, *Disgrace*, p. 247; our translation).

the expression that organizes the mental activity, that models it and determines its orientation. No matter what component of expressing-uttering we consider, it will always be determined by the real conditions of the utterance in question, that is, primarily by the *most immediate social situation*" (1929/1977: 123; our translation) or "An idea (...) is not a subjective individual and psychological formation, with a *fixed address* in the human head; it is interindividual and intersubjective (...). Taken as such, it is similar to the *word*, with which it forms a dialectic unit" (1929/1970: 137; our translation). These reflections provide support, at the language level, for a nonrepresentationist or nonencephalocentric view of the expression of cognitions. If Bakhtine's nonmentalistic view is less often brought forward,[8] his dialogism -- which Jacques finds somewhat weak[9] -- is quite well known. It shows up clearly in statements like the following, which reflect the bivocal character of the word-utterance: "Every word has *two faces*. It is determined as much by the fact that it comes *from* someone as by the fact that it is directed *toward* someone. It is precisely *the product of the interaction of the speaker and the listener*" (Bakhtine, 1929/1977: 123-124; our translation). For Bakhtine, the word is both a place and a historic event (for an in-depth analysis, see Brassac, 2003a: 54 *and sq.*). In its dynamic, the word-utterance condenses the relationship between the interactants. "The word is a sort of bridge between myself and the other person. If it rests on me at one end, it rests on my interlocutor at the other. The word is the common ground of the speaker and the listener" (Bakhtine, 1929/1977: 124; our translation), and "The word is not a thing but the ever-moving, ever-changing medium in which the dialogical exchange takes place" (Bakhtine, 1929/1970: 278-279; our translation). This is a truly interactionist approach, one in which the relationship takes precedence, one which opposes an egological approach.

Contrasting these two Soviet researchers, Bakhtine and Vygotski, Clot addressed a community of psychology researchers and wrote, "Let us also perhaps retain that, while Bakhtine is not a psychologist, he could very well help us be more so" (1999: 185; our translation). He obviously could not have addressed the community of discourse analysts in these terms. Bakhtinian dialogism has indeed largely impregnated studies conducted on the topic. However, it seems that its many linguist heirs have not taken the time to conduct an in-depth examination of his nonmentalism.[10] This is regrettable, since it would have paved the way to an extended position opposed both to egologism and encephalocentrism in matters of discursive production by human subjects. Accordingly, Gergen (1999/2001), who urges psychologists to return to taking the interactants' relationship into account, relies heavily on both Mead (while criticizing him nonetheless) and Bakhtine. The aim is to go beyond the egoencephalocentrism[11] that prevails in psychology, in the psychology of interaction, and also ... in discourse analysis. A possible route for doing so is to look at what the paradigm of situated and distributed cognition has to offer in this area.

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[8] Even though it is patent (see for example Bakhtine, 1929/1977: 47).

[9] We know Jacques's stance on Bakhtine's work: "I owe much to M. Bakhtine, but unwillingly" (1985: 102; our translation).

[10] There are no reflections like these in the book edited by Depretto (1997) entitled *L'héritage de Bakhtine*, which focuses instead on Bakhtine's contribution to the theory of literature.

[11] A term pertinently coined by Jean-Claude Kaufmann (2001).

2.2 Artifacts and Cognition

The subtitle Andy Clark gave to his recent book (*Being There*, 1997) is highly explicit: *Putting Brain, Body and World Together Again*. This book proposes a sort of synthesis of all studies conducted in the situated and distributed cognition paradigm[12] for what now amounts to about two decades. The basic idea is that human action, whether or not it is part of a goal-oriented activity, and whether it occurs in an individual or collective situation, is incorporated and does not unfold without recourse to a *device that inscribes it in the world*. Every dynamic action-based cognitive process is anchored in the space in which it takes place. This is the *leitmotif* that runs throughout an influential article in the field written by Conein and Jacopin and entitled "Situated Action and Cognition". It is the opening article of an issue of the journal *Sociologie du Travail* (*Work Sociology*) and offers a remarkable description of the subject and its epistemological foundations (including Mead and Vygotski) and founding references (including Suchman (1987), Lave (1988), Hutchins (1990), and Norman, (1993)). In this vein, Simondon (1958/1989) is often quoted: "Our point of departure will be *technical activity*, defined in reference to Simondon (1989) as the set of human actions needed to regulate the relationships between a technical object and its environment" (Dodier, 1993: 116; our translation). Along with Leroi-Gourhan's (1964, 1965) work, Simondon's studies laid the groundwork for reflection by researchers at the Technological University of Compiègne, where the relationship between technique and cognition is also examined. These researchers, principally Havelange, Lenay, and Stewart (already cited above), stress the importance of inscribing cognitive processes in external, nonmental supports, that is, technical objects. "Technical objects are not mere material objects. (...) An object is 'technical' *only* to the extent that it actually serves as a support for a representation activity, where a subject and the object of his intentional goal co-occur. (...) Technical objects constitute a form of *memory,* a locus of a double articulation between the individual and the social" (Havelange *et al.*, 2002; our translation). We are very close here to Vygotskian mediation, and more specifically to its instrumental facet examined in the highly interesting study by Rabardel (1995).

Inscription in the paradigm of situated and distributed cognition quite naturally highlights the crucial role played by objects in interhuman communication. In other words, this way of examining communicability, as a background to interactive phenomena, leads us to question the overly language-centered character of Jacques's proposals. It encourages us to reflect upon the function of digitized artifacts in joint cognitive processes, which are undeniably rooted in the dynamics of linguistic-form production and hence in conversations ... but that is not all.

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[12] I will not go into the reasons for the two modifiers. Just two points. First of all, as Conein himself admitted, there is no single way of naming things in this research field: "Under various names such as 'situated cognition', 'distributed cognition' and 'situated action', these studies deal with the same problems, such as the analysis (...) of the function and impact of 'intelligent' artifacts in the organization of human activities" (1994: 419; our translation). Secondly, when Hutchins was asked why he chose the term "distributed", he replied: "because *situated* was already taken" (personal communication, 2000).

3. Digitization of Knowledge: A Design-Use Dialectic

3.1 The Digital Artifact as a Communication Source and Resource

If it is relevant to contend that a dialogical and constructivist approach allows us to view computer-based devices in a dual role of support for, and configuration of, knowledge mobilization in human organizations, then one can assert that the bigger issue of the digitization of knowledge must be brought back into the foreground. Let us look at why. Researchers working on this vast project belong to a subdivision of artificial intelligence, the one whose goal is to *represent* human knowledge in the computer. They develop knowledge-based systems that integrate different modes of knowledge representation and manipulation (objects, graphs, semantic networks, procedures for categorizing and classifying, inference mechanisms, logics, etc.), all of which are ways of manipulating ... information. Their task is to develop knowledge engineering (KE), where the goal is to design and implement formal models to be installed in computers. This process amounts to developing digital artifacts capable of performing computations on entities whose function is to translate into digital format (codify) the cognitive procedures housed by human beings.

The general task of developing information-processing machinery is embedded in a dialectic between design and use. By this, I mean that producing (in the sense of constructing) this type of digital instrumentation must necessarily be based on a design objective that integrates its actual (not putative or presumed) utilization by future users of the artifact. There is an upstream and a downstream to this construction process, both of which must be taken into account, and above all, linked to the other.

Let us look upstream first. The design of the machinery cannot originate in the cognitive activity of human actors, for the gathering of knowledge -- which would be more accurately and wisely thematized as a construction process -- obviously takes place *via* an interaction between the computer scientist who is developing the model and the actor who specializes in the knowledge domain in question, the so-called expert. In other words, knowledge *gathering* is a joint activity that creates *something*, and that something is located somewhere between the to-be-codified cognitions mobilized in the interaction, and the information that will end up being included in the computational system.

Now what about downstream? How the machinery will be used later is often seen as secondary at construction time. The need to have the future actors in the organization where the CBD will we implemented actually and concretely use it in a real situation is generally not taken seriously enough. Yet if, as I argue, the CBD deeply modifies the subject's activity, in the sense that its use configures the actor's cognitive productions and thus structures his relationship to others, then it is crucial for the designer to find a way to foresee how the subject will appropriate the machinery he is designing. In short, the designer must put the very first prototype to use in an applicable situation where the actor is given the opportunity, by means of a real activity, to air the difficulties encountered during the appropriation process.

It will be easier to grasp the importance of this design-use dialectic if we consider the CBD's double status as a resource and a source. Indeed, if a CBD is but a means of mediation between actors, then we can settle for it simply being an optimal computation device. On the other hand, if the CBD controls the mediation dynamics, then the computation device will only be useful if it carefully articulates the joint mobilization of the knowledge necessarily produced during the human interaction.

It goes without saying that this type of approach has its enthusiasts in the French KE community. Refer, for example, to the studies conducted by Alain Mille's group at the LIRIS[13] (Champin *et al.*, 2003) or to the models developed by the ORPAILLEUR team at the LORIA[14] (Le Ber *et al.*, 2003; Lieber *et al.*, 2003). This has also been true for many years in certain branches of the human and social sciences. Some worthy studies are the ones on the Cautic method[15] (Mallein & Privat, 2002), the LUTIN[16] research by Dominique Boullier, and the work done by Christian Licoppe when he was head of the "Uses, Creativity, Ergonomics" Laboratory at France Telecom's Research and Development Division, all of which pertain to the sociology of use. Other related studies include the sociology research on situated action (Conein *et al.*, 1993) and my own research in psychology (Brassac, 2003a, 2003b).

As a social psychologist of collaborative cognition processes, I contend that interaction is the locus of the generation of semiotic forms. These forms have different appearances, including graphic representations, gestures, words, texts, or even three-dimensional objects or sound matter. Combinations of these different appearances are not only possible, of course, but are also very common. The interaction process, viewed as an idea-creating dynamic, is itself also made up of intricate connections between linguistic and gestural productions, in addition to relying on the utilization of artifacts (Brassac, 2003b). In other words, the jointly-achieved generation of cognitions occurs through the interleaving of things said and things done. The same holds true when a computer-based device is situated at the heart of the interaction. It is even accentuated by the fact that the CBD is a manipulator of semiotic forms, of "information".

3.2 Use as a Driving Force of Design

The situations we will analyze here clearly illustrate the points just made about the design-use dialectic. One of the situations concerns what happens upstream; it is a study about the design of a multimedia teaching tool. The other concerns what happens downstream and is discussed elsewhere in this volume (Hautecouverture *et al.*, 2004).

The experiment briefly presented here[17] concerns a use-supported design situation where the actual use of the computer artifact is the driving force of the interaction. To avoid having the user arrive during the final stages when the tool was nearly in working order, we set things up so that the user could intervene during an earlier phase of the design process, when the prototype was still in a rough state. We asked the developer of the tool (hereafter called DEV) to interact with a teacher in the field (hereafter called TEA) while running the prototype in a somewhat advanced stage of development. The user was a teacher of automation; the designer was a developer of multimedia teaching tools. With this setup, then, we had two human subjects carrying out a cognitive activity in a "natural" setting, by acting on the world through language and by using the objects in that world. The experiment was more or

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[13] Laboratory of Image Informatics and Information Systems.

[14] Lorraine Laboratory of Research in Informatics and its Applications.

[15] Use-Supported Design for Technologies, Innovation and Change.

[16] Laboratory of Uses in Digital Information Technologies (RNRT platform, La Vilette).

[17] For more details, see Brassac *et al.* (1998) and Grégori (1999a, 1999b).

less Vygotskian in nature, since it involved instrumental mediation and cognitive activity in a concrete, natural environment (Vygotski, 1934/1985; Rivière, 1990). To permit later analysis of the situation, the corpus was recorded in videotape format (in line with our emphasis on the interleaving of saying and doing). Two video cameras were used to obtain films from two angles, one aimed at the screen and the other at the pair of individuals.

The tool being designed was a software package that would assist teachers in preparing remote teaching courses using internet resources. The discipline taught was automation and the specific topic was the troubleshooting of automated systems. The course consisted of an organized set of computer files taken from two sources. The teacher could write text, draw diagrams, make graphs, and insert pictures. In short, he was the author of the files of the first type and therefore mastered their content. On the other hand, one of the main ideas underlying the project was to enable the teacher to "search elsewhere" for documents he did not write. In the present computer setting, "to search elsewhere" obviously meant to download. Files of the second type (not written by the teacher) were themselves of two types. During the first month of the project,[18] a database containing items related to the concerned teachers' domain of expertise was compiled. It contained text, sound, and image (static or animated) files and was available to the prototype designers. It will be called the local database or LDB. Additionally, the final tool would allow the user to link up to (and/or import) any files available on the web. In other words, the tool would enable its primary user (the teacher creating the course) to call up local and remote files. Thus, the teacher in the course-creating position had at his disposal two groups of files. For the first group, he knew what the files contained (structure and content of all files in the local database); for the second, he did not have a comprehensive representation -- and for a good reason, since this group of files included all files on the web potentially capable of meeting his needs in matters of automated system troubleshooting! The different statuses of these two sets of documentation in the genesis of the course-building process is obviously very important.

The session lasted an hour and a half. DEV described the state of the prototype while speaking and handling the mouse. His hand activity covered a large part of the screen: he highlighted, pointed, clicked, double clicked, dragged, and opened pop-up menus. These actions were accompanied by comments, descriptions, clarifications, and illustrations. At the same time TEA, whose eyes followed the events taking place on the screen, listened, interrupted, asked questions, showed surprise, and made comments and suggestions. He pointed to a few places on the screen with his finger or hand but not with the cursor (he never touched the mouse during the session). For the first half hour, DEV gave TEA a detailed description of the functionalities of the tool in its current state, while TEA indicated, with statements of agreement, that he understood what was being done. Remember that DEV had already worked at length on the prototype. Foreseeing how a teacher might use the tool, he had already solved a large number of problems, mainly pertaining to the interface and course-building flexibility. It was to become clear that a highly advantageous feature of the device was that it allowed the user to make use of resources not included in the written part of the course. These resources could be drawn from the LDB, which DEV knew quite well, or (and

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maybe even especially) from the entire internet! Right from the beginning of the session, DEV said in speaking about links: "You should know that your course content can come from anywhere on the planet" (2'28"). Obviously, neither DEV nor the course creator could possibly know this entire body of knowledge. The question thus became figuring out how to search for this type of resource. In fact, it was TEA who made this task the focus of the interaction (and thus of the joint activity of improving the prototype).

After the half-hour presentation, TEA expressed considerable dissatisfaction (29'59"). His remark was clearly a criticism of the developer, who understood it as such, since he then formulated the problem in an overt and relevant way, admitting that in its current state, the prototype did not allow the teacher to preview the files he might want to download.

TEA9   It's impossible to use it like that.

DEV9   Okay, so, make it so that, no no, but I get it, well make it so that, that, here when there's a list of things you can say I want to see that, I want to see that, sort of like a preview.

TEA10   Exactly.

This exchange ended the first part of the session.[19] The next step was to eliminate this flaw. The two actors attacked the problem by conducting an in-depth discussion as they worked with the prototype.

The following exchange occurred 24 minutes later (53'50").

DEV15   That means that here uh by clicking, I don't know where (1 s), say here, uh yeah here, I have a list, I say I want to see that, so I click, maybe I right click or I don't know what, or I give a function and, boom, it gives us, we get the content. Okay.

TEA15   You know, in Powerpoint, huh, uh, or that type of, I mean, you know the ...

DEV16   Previewing.

TEA16   Yes.

DEV17   It's a little like that here when you do in/ when you do insert picture (*clicks on a series of pop-downs*) uh from fi/ I mean that's/ I guess it would even be good (*a window opens on the screen*).

TEA17   Yes, ah ha, that's it.

DEV18   That, that, that would be ideal.

DEV15 reveals considerable hesitation on the part of the developer. His speech was filled with negations ("I don't know where", "I don't know what") and discursive modals ("uh" twice, "maybe"), which acted as markers of the fact that he was trying things out, that he was groping, that he didn't know what the screen would display as he manipulated the mouse. In DEV17, it seems that he hadn't tried out the feature he was testing. His remark "It's a little like that here" shows that he was experimenting. A window then appeared on the screen. It was a dialogue box, or more precisely, an insert-picture box from *Microsoft*® *Word*®. It jumped out at the actors. DEV said "I guess it would even be good", marking his surprise with a conditional verb. TEA expressed his immediate satisfaction using the present indicative: "Ah ha, that's it". The "even good" was then quickly rephrased by DEV as "ideal".

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[19] For a more thorough analysis, see Brassac and Grégori (2001).

Unlike the first part of the session (which lasted nearly an hour), the screen was no longer the artifact being used to accompany what was being said. For one hour, DEV presented what might be called the subservience of the events on the screen to his design of the prototype: when I want to perform such and such an action, this will happen on the screen; if it doesn't happen then it means that the interface still isn't working right. This presentation led TEA to point out his dissatisfaction, and led both actors of the design process to express the tool's inadequacy. From that point on, the screen no longer "complied" with the developer's instructions, for the simple reason that something had to be invented that he had not thought of earlier. A random, almost accidental maneuver (of the type "maybe we could try this") triggered a screen display that quickly proved critical. The state of the screen clearly revealed a solution, the insert-object box. This window would be quite suitable, with items to be inserted appearing in graphic form, as in the well-known "print preview". TEA caught on immediately and exclaimed "Ah ha, that's it". But what about the developer?

Many many indications of the developer's approval of the solution were spread throughout his discourse in the last half hour of the session. Most of them were obviously verbal. Here are a few, all proffered by the developer:

55'01" A thing like that would be ideal.
55'25" That's exactly it.
55'34" A thing like that, that would be super.
56'12" Uh huh, that, that would be ideal.
56'42" Yeah, that's exactly it.

These linguistic forms, the last of which was no longer expressed in the conditional, clearly reflect DEV's agreement and mark off a long commentary where he showed how this type of box was indeed a good solution. He seems to have become increasingly convinced about the window as he talked, continuing to manipulate it extensively for the remaining half hour.

DEV showed his acceptance of the outcome of the session in another manner too. The insert-object dialogue box remained on the screen (in full-screen format) for quite a long time without being erased (16 minutes). After four minutes, DEV seized this virtual object in a highly significant way. In the same was as one might wave a manual, a report, or a document during a meeting to insist upon its importance to the current discussion, point to and tap on a transparency at the spot where the key idea of one's speech is located, or grasp a tool to show others how indispensable it is, DEV seized the window as if to weigh its relevance. He did this using the mouse in a jerky, circular fashion that caused the window to rotate rapidly with a movement he controlled perfectly. At that exact moment (which lasted two seconds) DEV made the following highly important remark: "And the tool, it's basically no more than that, it's just that bit there" (57'47"). It was almost as if he had grabbed the object, this new key to the design process. Apparently feeling somehow overtaken by a device he knew how to handle for presenting the prototype, DEV was now exhibiting his appropriation of what had escaped him. Controlling this state of affairs, this "new" artifact whose actualization had occurred almost by chance within the material world of the interaction, was achieved by a kind of virtual possession of a virtual object. It was by way of its existence as a concrete, perceivable element of the interaction environment that the window acquired an active role in the design process.

Clearly, without the intervention of the potential user TEA at this early stage of the design process, the developer may not have realized the weakness of the prototype. This showed up in (i) his lack of awareness of the prototype's inadequacy, (ii) the surprise he exhibited (despite his excellent knowledge of the interface) during the display of what proved to be a good solution, and finally (iii) his repeated manifestations of acceptance of the solution. In

addition to the merits of the use-supported design aspect of the phenomenon reported here, it is the totally joint nature of the cognitive dynamics of idea-generating that is particularly interesting. But even more noteworthy is the role of the object in this distributed process.

Of course, the analysis proposed here is microscopic in scope, but that does not invalidate the proposal in any way. This computer-based device is much more than a medium of interaction, a claim that is perhaps easier to demonstrate when a device is still being designed as it was here. In fact, other studies have shown that the same can be true even during the utilization phase. The digital artifact is a resource for the collective production of cognitions and hence of knowledge. In the last section of this paper, I will try to show that the lessons learned here, extended to a wider range of situations -- no longer intersubjective but groupal -- can clarify the relationship between the use of digitized artifacts and knowledge management in organizations.

4. Digitized Artifacts and Knowledge Management

Today, computer-based devices end up occupying nearly all of the instrumentation space of communications among the actors of human organizations. It is becoming difficult to get along without a cell phone to interact with one's friends; computer skills are now required for nearly all jobs, whether in private companies or public organizations; and the use of digital techniques has invaded the educational and cultural world. The flow of knowledge in human organizations is supported by computerized artifacts, and as such, they have become precious resources for communication between the agents that keep them thriving. As stressed above, computerized artifacts should also be considered and studied as sources of collaborative activity. In this sense, we need to reflect at a larger scale about the function CBDs can serve in the area of knowledge management within human groups. Indeed, concomitantly with the growing use of computers in society's organizations, a knowledge-based economy is developing.

4.1 Flow of Knowledge and Collectives

Human activity, of whatever order, is always inscribed in a process that generates cognitive novelty. Joas (1992/1999) discusses at length the "creativity of acts", emphasizing the eminently creative nature of human action, be it simply linguistic or more generally concrete. All human behavior, whether actualized in a monologue or dialogue, is accompanied by a transformation of the world in which it occurs. When the action of a subject or group leads to a process devoted explicitly to the production of ideas, thoughts, or representations -- as in the case of a designer or a research and development team -- then the transformation of the world is the actual result of the activity. When the actors' actions consist in carrying out an ordinary or even routine task, the process is accompanied *ipso facto* by the acquisition of expertise and practical learning, which contribute to the transformation of more than just the material world, but also the immaterial world made up of intangible goods such as education, services, cooperation, and so on. Operators refine the way they handle the instruments they use, decision-makers reconfigure the interactions they have with other actors, designers acquire additional expertise, and creators revamp their relationship with the form they have fashioned. The transformation of the world, which is tied to every human action, finds its expression in the alteration of materiality (whether concrete, as it is in traditional artifacts, or *virtual*, as it is in computer-based devices), in the metamorphosis of the actors, in the modification of social relations. Human activity is thus envisaged in its radically and continuously innovative dimension; it is understood as a dialectic of modifications of both the actor

and the world in which the action occurs. The mobilization of knowledge is thus a conception, a creation that articulates metamorphoses of individuals and alterations of their material, social, and organizational environment.

Firms, and more generally organizations, must rise to meet a major challenge: understanding how knowledge is constructed, retained, and saved, exchanged and spread, how objects of knowledge contribute to the life of their departments and divisions. They must control the mobilization of knowledge. It is now well-established that such objects of knowledge are the products of activities, and that they are not simple data items or stable, fixed pieces of information. The activities in question are necessarily anchored in relational networks, which the actors keep alive by their talkings and doings. These activities are as much generators of cognitive processes as they are sources of the evolution of the human capital. Hatchuel insisted on the collective nature of the formation of such objects of knowledge: "As soon as we assume the joint instability of objects and relations, then knowledge management requires acting jointly on those objects and relations: we will use the term 'collective-design acting' to refer to a collective action whose target is the joint regeneration of ontologies and relations" (2002: 199; our translation). The properties of knowledge as an economic commodity are marked by their inscription in the collective activity.

Knowledge mobilization is configured by a set of procedures -- obviously conveyed by individuals and artifacts -- which are embedded in culturo-historico-social frameworks that bring to bear both human actors (individuals, small groups, organizations) and material devices (paper, telephones, computer-based devices such as personal computers, networks, etc.). It cannot be studied without drawing from the contributions of research conducted by (i) economists, managers, and law specialists; (ii) psychologists, sociologists, and philosophers; and (iii) computer scientists and engineers. Indeed, knowledge is taken to be an *economic* commodity whose *management* calls for specific modalities, which raises the question of ownership and legal issues; it is produced within *social* frameworks and is the correlate of the cognitive processes that *psychologists* study; it is inscribed in the epistemological frameworks that *philosophy* studies.

4.2 Codification and Flow of Knowledge

Computer scientists play a central role in this matter. They act at two levels: they build knowledge-based systems, and they design devices for sharing and spreading information. As we saw above, the first facet involves codifying knowledge and the second pertains to the machinery that makes cooperative work possible. Codification is obviously crucial to the management of potentially valuable immaterial goods. It controls their production, retention, capitalization, and other operations that perpetuate the otherwise labile procedures used to mobilize knowledge in organizations. The tools built by researchers *via* computer-supported cooperative work (CSCW) are also essential, since they enable social collaboration by providing efficient technical devices that do away with geographic distance. Digitizing knowledge and recording it on shared storage devices are two procedures that take a process embodied in a human being, a cognitive activity, and *translate* it into an automatic mechanism installed in a machine. Any study conducted in this framework is thus inscribed in an ongoing dialectic between the manipulation (computation) of information (by the CBD) and the (cognitive) mobilization of knowledge (by the human). What I would like to contend here is that this continuous back-and-forth activity can be theorized in a relevant way if we take a dialogical approach.

As it is envisaged here, a dialogical approach tells us two things: the knowledge of human subjects is overdetermined by sociocultural phenomena, and it is configured by their material environment. From this angle, computerizing to

share knowledge amounts to modelling and codifying the flow of collective knowledge anchored in relationships with others and with digitized artifacts. Once again, if, as psychologists of collaborative cognition processes, we understand CBDs as mere supports or media for these codification procedures, then we are underestimating their integrative function in the field of economics and knowledge engineering.

Conclusion

One way to address the issue of the relationship between artificial intelligence and society is to examine the social acceptability of computer-based devices designed and built by researchers in this discipline. The social acceptability of digitized artifacts is a crucial question for a society that is becoming increasingly grounded on knowledge. If it is true that the capital gains of the production systems of human organizations are henceforth based on the proper management of the flow of knowledge and know-how, which act as intangible, immaterial goods, then it is evident that the codification of that knowledge may be an effective means of producing value. Several disciplines are concerned with this issue (from economics to law, from sociology to business management, from philosophy to psychology). They are so in various capacities, but for at least one common reason: the mobilization of knowledge is always the doing of a group of humans. Yet the life of human collectives is deeply marked by socioeconomic and thus communicational mechanisms. Accordingly, interaction psychology, for instance, deals primarily with the mechanisms of information circulation, skill acquisition, collaborative design, and other kinds of knowledge diffusion.

By placing our research in the paradigm of situated and distributed cognition, I am arguing that an interaction is not a mere exchange of information based solely on the language dimension. I believe that every interaction is a dynamic process that shapes linguistic, corporal, and artifactual forms. This means that objects play an important role in the communication process, whether the object is a paper-and-pencil, a mechanical tool, etc., or ... a computer-based device. As such, digital artifacts contribute to the joint construction of meaning in interactive situations; they are sociotechnical devices that are not only a resource for this co-construction process but also a source of it. The position defended here is therefore dialogical and constructivist, one that grants artificial intelligence researchers a privileged place among the disciplines concerned with our knowledge-based economy. Indeed, their work of designing and developing computer-based devices puts them in a position to theorize the relationship between the computational manipulation of information and the cognitive mobilization of knowledge.

If it is possible for this theorization to be carried out *via* a well-thought-out articulation with the disciplines mentioned above, and by taking an approach based on the dialectic between design and use, then the concerned research community will be able to offer the heads of human organizations, those who manage the flow of knowledge, a valuable corpus to be updated in accordance with new interactions between academic research and organizational practices.

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