A SEMIOTIC APPROACH OF CONTEXTS FOR PERVASIVE SYSTEMS

Daniel Galarreta

Centre National d'Etudes Spatiales, 18, av. E. Belin, 31401 Toulouse cedex 9, France

Keywords: Context, Pervasive Systems, Context-aware Computing, Multi-viewpoints Semiotics, Organizational Semiotics.

Abstract: In this paper we examine the issue of contexts for pervasive systems and propose a semiotic definition of a context. We adopt a knowledge oriented approach – viz. a multi-viewpoints semiotics. We examine the relation between viewpoints and multimodality. The semiotic conceptual building we developed offers a convenient approach in elucidating the question of context. We give examples presenting a semiotic and multimodal context outside IT systems.

1   INTRODUCTION

«Man is the measure of all things ». This maxim of Protagoras (about 450 BC) applied to the project of information processing that has been thoroughly integrated into everyday objects and activities, leads us to wonder about the limits of the project. Indeed this project puts in a frontal way the relation of a universe attached to sciences of cultures (anthropology, sociology) with the one which is attached to "exact" sciences.

Organizational semiotics such as based on one hand on R. Stamper's works and continued by K. Liu and on the other hand on B. Andersen's works – and other remarkable researchers' works mainly from the Netherlands and United Kingdom – took well the measure of the existence of systems of symbolic representations strictly belonging to the domain of the human sciences for the elaboration of information systems (Gazendam, 2004)

But in its initial project – as in its practical target - the OS conceive the information system as an "onion": a computer system physically bounded and plunged into an anthropic environment.

In the project of a pervasive computing one is faced with the question of the "cohabitation" of objects endowed with a logical rationality - without affect and living outside the History - with human beings endowed with rationality but also with affects, living in the time, living in a language – a culture –, permanently in search of an identity, and ultimately destined to death.

If we consider some properties of pervasive systems, we easily notice a possible hiatus. Indeed with such systems the interaction with the environment is supposed to be "natural": it is then inevitably multimodal. It gets organized around the voice recognition, the gestural recognition and the manipulation of real objects.

Always with such systems the user has in principle the possibility of interacting (actively or passively), from anywhere with embedded software around him. In each case the interpretation by the computer system of the intention of the human subject is highly problematic.

Without going as far as evoking the questions of techniques of the body studied by the anthropologists – such as Marcel Mauss –, characterizing the human cultures, the way of spontaneously manipulating objects, of using them in coordination, can be strongly conditioned by the context. The place, the moment, circumstance where the interaction takes place strongly, determine the meaning of this interaction. When this interaction takes place without the human subject's knowing, the interpretation of the scene in which this interaction occurs becomes risky. Therefore a relevant dynamic adaptation of the system to this context is very difficult to carry out. Even in this case a pervasive computing is faced not with the question of communicating in sense of Shannon by exchange of symbols, but with the question of

participating to semiotic systems which have potentially the same extension as the natural languages and the cultures of the world.

In the conception of an information system in the sense of the OS, the conditions of functioning of the IT component were determined by relatively restricted anthropic environments. The method MEASUR proposed by R. Stamper for instance permitted the designing of the articulation of the various elements In the case of the pervasive systems, multimodality and the situations of ubiquity make the anthropic environments much more difficult to model. One of the major difficulties is to guarantee effective collaboration between a pervasive system and a human e.g. determining the various contexts in which the interactions take place. In this communication we investigate a semiotic modelling of these contexts. We suggest some possible development. In section 2 we remind definitions of context that were proposed in context-aware computing. In section 3 we advocate a semiotic definition of context. In section 4 we propose such a semiotic definition within a knowledge oriented approach of organizational semiotics – viz. a multi-viewpoints semiotics. In section 5, we examine the relation between viewpoints and multimodality and in section 6 we observe how a semiotic multimodal context may already be implemented in our environment.

2 DEFINITIONS OF CONTEXT

Considering the context in designing information systems is not a new issue. This is the case for instance, when we take into account the environment into which the information system is to be integrated. This approach is typically adopted by ergonomics. We can also note this concern in the way where organizational semiotics extends the information system to the whole organization by articulating the organised behaviour and data processing in a unified theory (Stamper and Liu, 1994), (Stamper, 2009).

If we extend our consideration to the whole domain of the computing sciences, we can observe that the context has been involved in to different domains such as natural language processing, machine learning, computer vision, decision support, information retrieval, pervasive computing and more recently computer security.

In their article Mostéfaoui et al. (Mostéfaoui and al., 2004) remind us that the term context-aware computing was first introduced by Shilit and Theimer (Schilit and Theimer, 1994) where they refer to context as: (**D1**) "the location of use, the collection of nearby people and objects, as well as the changes to those objects over time".

A similar definition is given by Brown et al in (Brown and al., 1997): (**D2**) "We define context to be any information that can be used to characterize the situation on an entity, where an entity can be a person, place, or physical computational object".

P. Brézillon and J.C. Pomerol (Brézillon and Pomerol, 1999) define context as: (**D3**) "all the knowledge that constrains a problem solving at a given step without intervening in it explicitly".

A.K. Dey (Dey, 2000) proposes a more generic definition that states: (**D4**) "Context is any information that can be used to characterize the situation of an entity. An entity is a person or object that is considered relevant to the interaction between a user and an application, including the user and the application themselves". A. Dey observes that *location*, *identity*, *time*, and *activity* are the *primary context* types for characterizing the situation of a particular entity. The primary pieces of context for one entity can be used as indices to find *secondary context* (e.g., the email address) for that same entity as well as primary context for other related entities (e.g., other people in the same location).

From a user's point of view, Gwizdka (Gwizdka, 2000) makes a distinction between *internal* and *external* contexts. *Internal context* describes the state of the user and may include the work context (e.g. current projects and their status, status of to-dos, project team), personal events i.e. events experienced by the user), communication context (i.e. state of interpersonal email communication), and emotional state of the user. *External context* describes the state of the surrounding environment. It may include location, proximity to other objects (both people and devices), and temporal context.

Adopting the distinction of Gwizdka, we simplify it in the following way. The *internal context* can be understood as the **knowledge** that the user has and that he is capable of mobilizing at the given moment. The *external context* can denote all the potentially significant elements which the physical environment can provide to the user in order to carry out his/her tasks - for example finding the closest Italian restaurant opened.

What we observe then is that the interaction between the user and its IT environment is conditioned by both types of contexts at the same time. The problem is then to grasp in a satisfactory way the internal context in connection with the external context: the aimed goal is to start the treatments or the most adequate actions with respect

to the expectations of the user. According to us, the previous definitions of contexts (D1 to D4), present all the defect to implicitly admit the possibility of describing objectively the context - internal and external - of a user. They all underestimate not to say ignore the epistemological issue that this description poses. We propose below in this paper a definition of context that rests upon the concept of point of view which we shall examine later. This definition presents the advantage, with regard to the previous definitions, to explicitly put emphasize upon the cognitive dimension of the context and solve that epistemological issue.

3 IS THE NOTION OF CONTEXT NECESSARY?

This distinction between "internal context" and "external context" is here only temporary. If the interactions of the subject with a distributed IT environment depend at the same time on an internal context and on an external context, therefore it is not sure that a description of this external context is "objective". Symmetrically it is not sure that the internal context only owes its existence to internal cognitive resources attached to the subject. On the contrary the mutual dependence of both forms of contexts militates rather for a unifying approach which renders the coupling of the human subject and its environment.

We do believe that such an approach should be a semiotic one since the objects which the human subject perceives or conceives, are first of all significant objects that is elements susceptible to be grasped or produced within the framework of a semiotic system. This grasping (or this production) takes place during a semiotic process.

We will soon describe such a semiotic system that offers such a unifying approach. For the moment let us note how textual semantics considers context (Rastier, 1998). Such an approach shares several intuitions with our own approach – reminding here that a text is synonymous to a semiotic production.

According to F. Rastier (Rastier, 1998) and to our own semiotic project internal and external contexts are both culturally situated. "The context agrees with the critical thought. Indeed, the context moves as the gaze moves, and thus the thought of the context is a thought of points of view. Now, for the critical thought the subject and the object do not pre-exist, and occur mutually in their coupling".

However supporter of the semiotics of Discourse – such as J. Fontanille – question the belief that context is necessary notion. This approach is interesting with respect to our own project as far as it proposes a unifying approach of all signifying objects whichever their semiotic modes (verbal, visual, etc). We will return later to that point (see viewpoints and multimodality)

For instance J Fontanille notices (Fontanille, 1997) that it is the point of view of the text, in the hermeneutic perspective which obliges to add, contextual elements otherwise the interpretation remains incomplete, and the understanding, unsatisfactory. On the other hand discourse – as opposed to text –does not require using context, not that discourse includes context as an additional part, but because the notion of context is not relevant from this point of view. Indeed, the point of view of the discourse neutralizes the difference between text and context: to adopt the point of view of the discourse, is to admit at once that all the elements which contribute to the process of meaning belong by right to the signifying set, that is discourse, and whoever they are. In brief, it is the point of view of the text that "invents" the notion of text. However the other problems rise when one is to adopt the point of view of the Discourse. Indeed one has to deal with the conjugation within the same process of several semiotic modes: verbal, visual, auditory, even olfactory, proxemic modes, etc." It raises de facto problems of inter-semiotic relations, in particular in the construction of a syncretism between various semiotic modes and the logics.

4 SEMIOTIC MODELING OF CONTEXTS

In this section we propose one general semiotic modelling of the contexts which allow tackling internal and external contexts in the same way.

In order to do that we situate ourselves within the framework of organizational semiotics and adopt the approach which H. Gazendam defined as a knowledge-oriented approach – as opposed to *system-oriented* and, *behaviour-oriented* approaches (Gazendam, 2004). This approach considers knowledge as representations or sign structures in the human mind, enabling adequate behaviour of the human actor. "Within organizations, knowledge can be created by processes of construction. Knowledge about something that does not exist yet but has to be constructed (for instance, a new aeroplane, or new computer program) has to be attained by a process of

discourse. In this process, actors take viewpoints based on their specialist knowledge and organizational role. Based on these viewpoints, views are expressed. In a process of negotiation, views are exchanged, compared, criticized, and possibly changed, with the aim to reach a set of compatible views that can be seen as organizationally constructed knowledge" (Gazendam, 2004).

For the sake of a general modelling of the contexts we have in view, it is necessary to remind briefly how this general approach, is implemented in our own work (Galarreta, 2008).

4.1 Definition of a Viewpoint

In accordance with intuition, we define a viewpoint as the way an individual or a group of people form (grasp or produce) a *signification*. Accordingly, we will define it as an individual or a collective viewpoint.

We draw on the definition that L Hjelmslev gives of signification within the framework of his theory of the language. This precision gives us the occasion to indicate that the references to the Hjelmslev's theory will be reduced to the minimum. Let us try for instance to define intuitively what Hjelmslev means by signification.

The expressions 'dog' in English, 'Kringmerk' in Eskimo, سگ in Persian or कुक्कुर in Sanskrit have all the four, the content dog. However even if each of above expressions means dog in all the four languages that we choose, they do not imply that a native writing or uttering it has the same view whichever his/her language. An English man or woman even would have in view a domesticated animal trained for hunting or watching or may be, used as a companion animal. But other semantic definitions are possible quite different from the previous one. In Eskimo society the [content] dog is equivalent to working dog used as a sled dog. The Persian would define it as a sacred animal. Hindu people on the opposite would have a pejorative definition of it as a pariah (Hjelmslev, 1971a)

In this example we have at least four definitions of the content 'dog'. We will say that there are four *meanings*, or in Hjelmslev's terms, four different *substances* of the content associated to the same *form* of content. As a form of content, 'dog' contrasts with other possible forms of content such as 'cat' or 'cow'. The mechanism which associates a *form* of content to a *substance* of content is denoted by Hjelmslev as a *signification*. We adopt this definition.

These different meanings that occur on the plane of content according to the culture of the speakers correspond to as many *views* produced from as many different *viewpoints*. Let us admit that this definition is sufficient for us within the scope of this paper. As Hjelmslev stressed it, this mechanism of signification transposes itself onto the plane of expression. This transposition is essential for us. We will return to it when we examine the question of multimodality.

On the basis of this definition of viewpoint, it is necessary to emphasize a point in relation with this process of negotiation, where "views are exchanged, compared, criticized, and possibly changed, with the aim to reach a set of compatible views that can be seen as organizationally constructed knowledge" (Gazendam, 2004). This point is the following. Let us call *confrontation of viewpoints* the first phase of this process where views are exchanged and compared. In order that a signification can be formed, that is, in order that a viewpoint is comprehended, it is necessary that this viewpoint can confront itself with another viewpoint. In other words, a viewpoint could not exist – at least could not be comprehended – if there are not any other viewpoints since no signification can be formed in this case. The proof of this claim is based on rephrasing of the description of the formation of the signification proposed in the article of Hjelmslev (Hjelmslev, 1971a). In this transposition, a confrontation of viewpoints is identified with semiosis (Galarreta, 2008) – or with the semiotic function, in Hjelmslev's term. This condition of existence – and of analysis – of viewpoints is one of the more notable epistemological features of the semiotic theory which as a conceptual building, aims at clarifying the condition of grasping and of production of the meaning of "being in the presence of other viewpoints". This is this theoretical project that we call a *multi-viewpoints semiotics*

4.2 Elements of a Multi-Viewpoint Semiotics

View (with respect to a viewpoint): we have identified it with the signification produced by the viewpoint.

Let us insist on the fact that a viewpoint could not exist apart from a situation of confrontation with other viewpoints. However the necessity of a confrontation is in no way related to the fact that the resulting significations are assessed well formed or acceptable as on a semantic plane.

Correlation of viewpoints: What can be observed in many cases (with respect to a given viewpoint) is that new significations – or views – are produced which are judged as better formed or more acceptable. A similar evolution is to happen for the other viewpoints in presence. We will denote these conjoined evolutions, the *correlation* of the viewpoints in presence. Even if they can be observed, these evolutions are not yet described within our theory since they are akin to a negotiation process.

Within this framework it is possible to define such notions as *knowledge*, *context*[14], and *identity* (Galarreta, 1997).

- *Knowledge*: A piece of knowledge is a view with respect to a viewpoint as a result of a correlation process with other viewpoints, assuming that a confrontation took place before.
- *Context*: A context of a piece of knowledge with respect to a viewpoint at a given moment is the corresponding viewpoint and the collection of viewpoints that are correlated with this one at that moment.
- *Identity*: The producing of a piece of knowledge therefore takes place during a negotiation process. This process is interpretable as the repairing of the identity of the object: (a) being designed or (b) manifesting an anomaly the cause of which is looked for, or (c) being the target of a risk analysis process.

Let us summarize the results we obtained. In order to overcome the distinction between internal and external contexts and have a unified approach of context at ours disposal, we propose a definition based upon viewpoints and knowledge. Within our semiotic project – viz. our multi-viewpoints theory – viewpoints and knowledge receive a precise acceptation. Within this theoretical framework, any semiotic "object" emerges from a process combining first a confrontation then a correlation of viewpoints. A view of this object is then (a piece of) knowledge about this object. In such conditions the context of this knowledge does not depends on the fact that the object is materialized or not. And the viewpoints that define this context get their existence from their mutual confrontation.

5 VIEWPOINTS AND MULTIMODALITY

Although Hjelmslev advocates the equivalence of the plane of content and of the plane of expression,

this position is not intuitive.

Indeed the content is usually assimilated to thought and the plane of expression to a coding. While content is associated with an interiority, expression corresponds to an exteriority. It is for this reason that expression is wrongly considered as a coding of a thought. This thought is often identical – at least for English speaking individual – to utterances expressed in English which could therefore appears as the universal language of human thought.

As soon as we consider a language that we cannot speak fluently, it is natural for us to reduce it to its plane of expression. It is for that reason that we shall say that the execution of a gesture or a series of gestures in order to *accept* or *refuse* something, *point to* something or *thank* someone, are the expressions of such contents – expressions of which we can give a version in English.

If on the other hand I say that such expression – meaningful and expressed in natural language, for example « yesterday, I worked » – signifies the execution of a given gesture or a series of gestures – for example by using the sign language (see fig. 1) – then I seem to reverse the usual orientation of the attribution of content in an *expression*. Nevertheless in this case "Yesterday, I worked" becomes the *expression* of a *content* which is the corresponding sequence that produces someone using the sign language (Moody, 1983).

One can object that it is only another coding such as this one: If I say "good morning" it means 'yes', if I say "How are you", it means 'no'. But in such a case we would not be any more then in the case of language such as English, French or sign language that Hjelmslev defined as not restricted languages (Hjelmslev, 1971b) by opposition restricted languages – which correspond roughly speaking to formalized languages. Hjelmslev in this article detailed the features that possess a non restricted language and that distinguish it from a restricted language. For instance in the case of a *non restricted language* it is impossible to reduce the two planes to only one thanks to an isomorphism that could have existed between the two planes.

Let us return to the example related to the sign language. The *expressing* in English of gestures or series of gestures considered as elements of *content*, transforms the plane usually associated to a translation in English into a plane of expression. It is therefore the plane associated to gestures which becomes the plane of content. Such a conversion depends on the point of view of the analyst who analyses and describes the signifying elements that he/she is faced with. With other words, such

conversion depends on the fact that the analyst decides to adopt the point of view either of *hearing person* or of *deaf person* (practicing the sign language). Once the choice is made, the proper character of each type of analysis follows. This choice is generally not a matter of will but rather a matter of natural competency of the analyst.
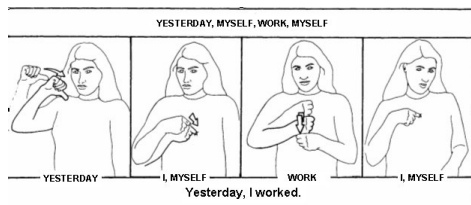

Figure 1: Inversion of the planes of content and expression when shifting from the viewpoint an English speaker to the viewpoint of person using sign language. (Moody, 1983).

One should expect that an analyst who adopts the point of view of the sign language, produces an analysis of the two semiotic plane using (or in reference to) sign language. Symmetrically, an analyst adopting the point of view of English or French should develop his/her analysis of those two semiotic planes using accordingly English or French.

Let us emphasize the fact that for an analyst the expression is always associated to a particular modality: auditory, visual, and tactile (e.g. Braille) and kinaesthetic. This characteristic cannot be ignored. The plane of content is analysable in the language of the analyst whereas, the plane of expression faces the analyst with its otherness.

In this example, we will remember that the viewpoint of the other – the one of the deaf person in the case of a hearing analyst, or the viewpoint of the hearing person for a deaf analyst – associated to the semiotic plane of expression is always marked by a modality.

The situation we described – a deaf person practising the sign language and an analyst being alternatively deaf or hearing – could appear marginal. In fact, it illustrates after being transposed, a rather usual situation. It is for instance the case of a person who translates a text from one language to another. It is also the situation of someone who is trying to understand a "difficult" text.

When the understanding of the text is obtained, that is when the confrontation – i.e. the interpretative process – succeeded, the meaning effect appears which creates the illusion that the "thought" is entirely within the plane of content and that the plane of expression is itself so to speak absorbed within the plane of content.

6 IMPLEMENTATION OF A SEMIOTIC MULTIMODAL CONTEXT

From the previous section follows that the viewpoints are neither internal nor external since that qualification depends on the position of an analyst, besides within this analysis, each viewpoint is marked with a particular modality. It therefore turns out that the existence of knowledge – and of its associated semiotic object – of context and of corresponding identity – for that object – depend on multimodal situation: a process combining first a confrontation then a correlation of "multimodal viewpoints". This way we adopt in analysing this situation is confirmed by works conducted on multimodality outside the semiotic field. We can draw several lessons from these works for the design of a pervasive environment.

A first example is provided by works carried out within the domain of literacy and education. In an article entitled "Sedimented Identities in Texts: Instances of Practice", (Rowsell and Pahl, 2007) two research Jennifer Rowsell and Kate Pahl, examine the role of multimodality

They insist on the fact that "the process of making meaning starts when meaning makers assemble Discourses [...] negotiate them, transform them, and materialize them in a text/artefact". They described this process as pattern recognition. "Thinking and using language is an active matter of assembling the situated meanings that you need for action in the world". "Fundamental to the concept of sedimented identity is the understanding that individuals (children, adolescents, and adults, differently but equally) make meaning and produce texts through multiple modalities. This understanding needs to be a starting point in literacy research". "Researchers can identify the concept of sedimented identities when tracing identity narratives over time, in ethnographic projects, for example. They can do so when coding transcripts and making links between texts, such as children's texts, oral discourse, parental narratives, and home field visits. Visual data can also fill out and enable understanding of the history of texts and text making across the domains of home and school".

In a different context the researcher Minoru Hokari tried to explore (Hokari, 2000), what is the meaning of (1) movement, (2) an open and flexible system of knowledge, and (3) the three temporal dimensions, in the Gurindji mode of historical practice. The Gurindji are aboriginal from the

Daguragu Aboriginal Community, Northern Territory (Australia).

It is not possible to sum up this interesting paper. But we will mention importance of mobility in their historical practice. For Gurindji, history is happening all over the country so that their mobility is essential to physically access history. Furthermore, mobility creates the unique relationship between their 'self' and the world. They find their 'self' in relation to the web of connection: connection with other beings, other countries and other community members. Naturally, their historical practice becomes relationalised into the web of connection as well. They are not the central figure of a practising history. Nor can they practise the history by themselves. Instead, their historical practice must 'connect' to the places, Dreaming, countries and people. It is therefore interesting to emphasize the fact that their knowledge is distributed. Using our semiotic framework, we can say that thanks to their movements throughout their environment –mental or physical – they are able amplify the confrontation and correlation of their viewpoints. "Places and your body connect each other and create histories every time differently in particular contexts». Those examples we examined are not based upon IT systems but stresses the fact that there exists in our environment distributed tools that allows so to speak "writing" of "objects" involved in semiotic processes. By their distribution in our everyday life and by the multimodality that they induce, they contribute to the production of identities and of a collective memory.

7 CONCLUSIONS

After considering different acceptation of context in use in context-aware computing, we advocated a semiotic definition of context. We proposed such a semiotic definition within a knowledge oriented approach of organizational semiotics – viz. a multi-viewpoints semiotics. We then examined the relation between viewpoints and multimodality and observed how a semiotic and multimodal context may already be implemented in our environment. The semiotic conceptual building we developed offers a convenient approach in elucidating the question of context. What can be remembered from the examples we proposed, is the possibility of a "semiotisation" of our external environment – intimately related to our semiotic competency – a "semiotisation" level for man.

REFERENCES

Brézillon P., Pomerol, J.C., 1999. *Contextual knowledge sharing and cooperation in intelligent assistant systems*. Le Travail Humain, 62(3):223–246.

Brown, P. G., Bovey, J. D., Chen X, 1997. *Context-aware applications: From the laboratory to the marketplace*. IEEE Personal Communications, 4(5):58–64, October.

Dey, A. K., 2000. *Providing Architectural Support for Building Context-Aware Applications*. PhD thesis, College of Computing, Georgia Institute of Technology.

Fontanille, J., 1997. *Sémiotique du discours*. Presses universitaires de Limoges.

Galarreta, D., 1997. *A viewpoints approach of context and memory in the empiric case of a space mission*. European Conference on Cognitive Science. April 9-11, Manchester, UK. (pp. 243-247).

Galarreta, D., 2004. *Designing Space Systems in multi-viewpoints semiotics*, In: Liu K (eds), Kluwer Academic, Dordrecht, The Netherlands.

Galarreta, D., 2008. *A Contribution of a Multi-Viewpoints Semiotics to Knowledge Representation Issues*. ICCS 2008 Toulouse, 11 July.

Gazendam H. W. M., 2004. *Organizational Semiotics: a state of the art report*. Semiotix, 2004, Volume 1, Issue 1. March 23. http://www.semioticon.com /semiotix)

Gwizdka, J., 2000. *What's in the context?* Proceedings of Workshop on The What, Who, Where, When, and How of Context-Awareness, Conference on Human Factors in Computing Systems (CHI 2000), April.

Hjelmslev, L., 1971a. *La stratification du langage. Essais Linguistiques*. Les Editions de Minuit, Paris,. (pp.45-77).

Hjelmslev, L., 1971b. *La structure fondamentale du langage*. In *Prolégomènes à une théorie du langage*. Les Editions de Minuit, Paris. pp.179-231

Hokari, M., 2000.Gurindji, P*erspectives on History: Body, Place, Memory*, Habitus 2000: A Sense of Place, J.R. Stephens (editor), Perth: Curtin University of Technology.

Moody, B., 1983. *La Langue des Signes*. International Visual Theatre. Ellipses. p. 75.

Mostéfaoui, G. K., Pasquier-Rocha, J., Brézillon, P . , 2004. *Context-Aware Computing: A Guide for the Pervasive Computing Community*. Proceedings of the IEEE/ACS International Conference on Pervasive Services (ICPS'04). IEEE 0-7695-2535-0/04.

Rastier, F., 1998. *Le problème épistémologique du contexte et le statut de l'interprétation dans les sciences du langage*. In Diversité de la (des) science(s) du langage aujourd'hui. Langages, N°129.pp.97-111.

Rowsell J., Pahl, K., 2007. *Sedimented Identities in Texts: Instances of Practice*. Reading Research Quarterly, Vol. 42, No. 3 (Jul. - Sep., 2007). (pp. 388-404).

Schilit, B., Theimer, M., 1994. *Disseminating active map information to mobile hosts*. IEEE Network, 8(5):22–32, July.

Stamper, R.K., Liu K., 1994. *Organisational Dynamics, Social Norms and Information Systems*. Proceedings of the Twenty-Seventh Annual Hawaii International Conference on System Sciences, IEEE 1060-3425194

Stamper, R.K., 2009. *A Pragmatic Web Workshop*. I-Semantics '09, Graz, Austria.