THEORIES AND METHODOLOGIES
THÉORIES ET MÉTHODOLOGIES

CONVERSATIONAL REMEMBERING IN TEAMS OF ROAD ACCIDENT ANALYSTS: USING A MODEL OF COLLECTIVE MEMORY FOR DESIGNING AN ORGANIZATIONAL MEMORY SYSTEM*

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RESUME

REMÉMORATION CONVERSATIONNELLE PAR DES ÉQUIPES D'ANALYSTES D'ACCIDENTS DE LA ROUTE : UTILISATION D'UN MODÈLE DE MÉMOIRE COLLECTIVE POUR LA CONCEPTION D'UNE MÉMOIRE ORGANISATIONNELLE

En proposant aux concepteurs de systèmes de mémoire organisationnelle de considérer ce type de mémoire non plus comme un objet passif, mais comme un processus actif (la remémoration), Bannon et Kuutti (1996) ont implicitement incité les concepteurs en question à considérer des modèles de la mémoire active tels que ceux de Bartlett, Neisser, Vygostky ou Zinchenko comme des guides possibles pour la conception ou comme des sources possibles pour élaborer des modèles de conception. La question se pose cependant de l'applicabilité de ce type de modèles pour la conception de systèmes qui seront utilisés dans des situations particulières : Quelles adaptations sont nécessaires pour rendre ces modèles utilisables s'ils sont utiles ?

On décrit ici une étude sur l'applicabilité d'un modèle psychosociologique de la mémoire à partir d'une approche « situationnelle ». Le modèle est celui de la remémoration (collective) conversationnelle d'Edwards et Middleton (1986) et de Middleton et Edwards (1990). L'approche, dite de la conscience des situations, est fondée sur un modèle de la situation d'interaction verbale empruntè à Kerbrat-Orecchioni (1990); d'après Brown et Fraser (1979). Cette approche permet d'évaluer l'applicabilité d'un modèle de mémoire par une « prise de conscience » :

1 / des situations sous-jacentes au modèle et à l'utilisation de ce modèle, c'est-à-dire de la ou des situations à partir desquels le modèle a été élaboré (situations sources) *et de la ou des situations dans lesquelles opèreront les processus à assister* (situations cibles) *;*
2 / de la compatibilité entre situations sources et situations cibles.

Cette approche a servi à confronter le modèle de la remémoration conversationnelle aux pratiques de mémoire des équipes de spécialistes en analyse d'accidents de la route du Département « Mécanismes d'accidents » (DMA) de l'Institut national de recherche sur les transports et leur sécurité (INRETS). Les résultats de cette confrontation montrent en particulier :

1 / la diversité des situations de mémoire que l'on peut rencontrer au DMA, comparée à la situation unique à partir de laquelle le modèle de la remémoration conversationnelle a été élaboré ;

* Un texte en français proche de cet article peut être obtenu auprès de l'auteur.

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2 / la nécessité d'adapter aux situations du DMA les fonctions mnémoniques composant le modèle (fonctions de tâche, fonctions de correspondance et fonctions d'évaluation) et de compléter ces fonctions par, entre autres, des fonctions en amont et en aval des fonctions existantes (fonctions de mise en condition et de stockage) et par des fonctions de reconnaissance (et non plus seulement de rappel) ou de mémorisation (et non plus seulement de remémoration) ;

3 / la nécessité de rendre compte davantage dans le modèle des structures mnémoniques (en particulier des cadres de remémoration et des représentations externes médiatisant les activités de mémoire).

On discute pour terminer les implications du modèle et de ses extensions pour la conception d'une mémoire organisationnelle fondée sur la « conversation ».

Mots-clés : *Mémoire collective, Mémoire organisationnelle, Remémoration conversationnelle, Conscience de la situation sous-jacente, Collecticiels.*

I. INTRODUCTION

When they proposed to designers of organizational memory support systems to no longer view memory as a passive store, but to reconsider it as an active process (remembering), Bannon and Kuutti (1996) implicitely prompted system designers to consider the models of remembering they mentioned (*e.g.*, the models of Bartlett, Neisser, Vygostky, or Zinchenko) as *candidate reference models* for informing and guiding the design of memory systems, or as *candidate reference sources* for developing design models.

Bannon and Kuutti also implicitely incited designers, and more generally organizational memory researchers, to search for and use other existing models of active memory. This appears to have been done by researchers such as Sauvagnac, Falzon, and Leblond (1997), who referred to Scania de Schonen's model to characterize collective memory within various operators' groups (maintenance workers in an electricity company, operators in a tube factory, composite-material head assistants in aerospace industry).

When reading Bannon and Kuutti's proposal, I was also prompted to use another model of active memory for informing the design of a potential "active memory system" aimed at road accident analysts of the Department of Accident Mechanism Analysis (henceforth DAMA) of the French National Institute for Transport and Safety Research (INRETS). The model is the so-called "Conversational Remembering" model of Edwards and Middleton (1986); Middleton and Edwards (1990).

The question then arose to me of the *applicability* of the model: how useful (or relevant) and usable was it? To prove usable, models need to be operational, and, as a prerequisite, useful. To prove useful, models need "to capture critical aspects of doing things" (cf. Norman, 1986, p. 38). How do we assess that a model captures the critical aspects of action? The situated-action perspective can help us determine this. From this perspective, action depends upon its natural and social circumstances, that is, its *situation* (or context). From this we can derive that

some of the critical aspects of a model are situational (or contextual) factors. A way of determining the applicability of a remembering model thus consists in taking into account the situation in which remembering fits, and in eliciting critical elements from this situation. Depending on the results of this applicability assessment, model adaptation can be more or less important.

In this paper, I report an applicability assessment of the "Conversational Remembering" model, using a situational approach I called the *Underlying-Situation Awareness Approach*, and contrasting the model with the practices of DAMA analysts' teams. I first present the model (Section II), the approach (III), and the DAMA site (IV). I next (V) describe the comparison method operationalizing the approach. I then report the main contrasting results, and the resulting model adaptations, in terms of remembering situations (VI), remembering functions (VII) and remembering structures (VIII). Finally (IX), I discuss some implications of the adapted model for system design in terms of requirements.

II. THE MODEL OF CONVERSATIONAL REMEMBERING

The model of Edwards and Middleton (1986) represents the "ways in which people construct a joint account, in conversational discourse, of a particular common experience" (p. 423). It has been derived from a "qualitative, content-oriented treatment of raw dialogues" (p. 423). These dialogues involved psychology students who were requested to remember and talk about the film *E.T.* they had seen six months ago. Here is an example of a dialogue sequence produced by the students J, L, D, and T (see interpretation further):

Sequence 22

J: before that happens you've got the bit where he hides in the wardrobe and the mother comes in
L: no [that that's later*
D: [no that's later*
T: that's a lot later
D: mm
J: oh

* Simultaneous utterances.

II.1. MEMORY FUNCTIONS

Edwards and Middleton's model focuses mainly on the functions of discourse in joint remembering. It consists of three hierarchically related sets of functions (see Fig. 1) which discussants realize through various communicative devices.

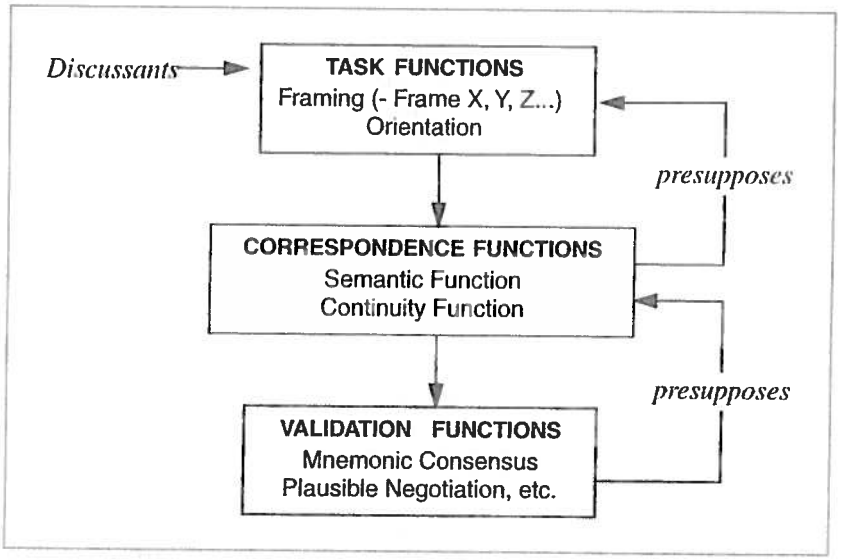


Fig. 1. — A Hierarchy of Joint Recall Functions (Edwards & Middleton, 1986)
Hiérarchie des fonctions de rappel collectif (Edwards et Middleton, 1986)

Task functions. — The first set of functions include *framing* and *orientation. Framing* refers to establishing a frame and criteria for joint recall. Frames can be sequential narrative, affective reminiscence, and so on. Criteria can be significance, accuracy, memorability, impressiveness, and so on. "Affect-based remembering" (that is, remembering involving the discussants' own reactions and evaluations) prevails. *Orientation* refers to the ways in which individuals accordingly locate themselves vis-à-vis the account in relation to the point where the account has reached at any time. Orientation occurs within the task frame.

Correspondence functions. — The second set of functions refer to the essential task of joint narrative reconstruction, namely "establishing a correspondence between the original story or sequence of events and the account" (p. 433). They split into semantic function and continuity function. *Semantic* (or *content*) *function* refers to putting experiences into words. *Continuity function* refers to ordering the things recalled: participants introduce and locate remembered events "in terms of the simple sequentiality of events ('temporal' continuity), the referential connectedness and cohesion of the unfolding discourse ('referential' continuity), and also by appeal to the intrinsic rationality or likelihood of things ('plausible' continuity)" (p. 438). The following operational modes serve both the semantic and continuity functions:

— *Build-up sequences:* Several persons contribute part of an overall remembered item, event, or series of events;

— *Requests for mnemonic help:* People can ask each other to help them remember, and identify particular items or events, and their narrative ordering;
— *Meta-comments for solving problematic recall:* meta-comments occur where remembering itself is problematical.

Validation functions. — Remembering validation is performed in particular through "mnemonic consensus" and "plausible negotiation". *Mnemonic consensus* refers to establishing a joint, undisputed, shared version of the past, or a consensus account of things. *Plausible negotiation* refers to constructing a coherent and sensible account in which particular events have a natural sequence, and in which there is a recognizable "human sense" (based on human relations and experience).

Communicative devices. — Conversation partners perform all the functions through communicative devices such as:
— *Tags* to signal or to invite ratification ("Doesn't he");
— *Overt agreements* ("Yeh that's it");
— *Overt requests* to assist the joint task ("And what's that little girl that he fancies");
— *Metacognitive formulations* of the process of remembering itself ("That's right I remember").

Sequence 22 above illustrates validation functions and their associated devices. It shows that negotiation of a consensus account of the past could be achieved by assertion and acceptance: J's version of events was firmly rejected by three other discussants, and J conceded (see also Clark, 1992).

II.2. Memory structures

A major but not developed claim of Edwards and Middleton's functional model is that the frames required for remembering are not simply knowledge structures (such as scripts, schemata, etc.), but communicative ones. These frames govern in many cases remembering content and structure, and especially joint reference ("within which a consensus of affect, evaluation, and recall can be negotiated").

II.3. The model and the design of a memory system

Although it was not elaborated for design purposes, the Edwards and Middleton's model can however be considered as a good candidate for memory system design. First, it is a true model of *active* memory: it is Bartlett's model "revisited" (see Edwards & Middleton, 1987). Second, it is indeed a model of *collective* memory, contrary to the major active memory models referred to in the introduction, which deal with remembering performed individually, or which are not really interactive (see Middleton & Edwards, 1990). Third, it involves *conversation*, a key factor of organizational learning effectiveness (see Conklin, 1996; Senge,

1990). Fourth, it presents some *ecological validity* (see Neisser, 1982): derived from the observation of actual practices of collective memory, it would present some resemblance to the situations in which remembering is ordinarily done (see Middleton & Edwards, 1990). Finally, it describes *functions* that, if appropriate, could be translated into machine functionalities.

III. USING A MODEL OF MEMORY FOR DESIGNING A MEMORY SYSTEM

III.1. MODELS *OF* MEMORY VS. MODELS *FOR* MEMORY DESIGN

Designers need models *for* memory design, that is, models that can be applied to the design of memory systems. Unfortunately, Edwards and Middleton's model is a model *of* memory—a model not intended to inform and guide system design, but to improve our general knowledge of memory. Starting from such a model of memory (or *model-of*), how to arrive at a model for memory design (or *model-for*)? In other words, how to assess Edwards and Middleton's model applicability?

To do so, it would be necessary to specify the distance between the present status of the model (model-of) and the expected status (model-for). The distance can depend on the design phase where to apply the model; *e.g.*, a model for requirements analysis will not need to be as specific as a model for implementation. The distance can depend also on the system to design; *e.g.*, a model for computer-human communication would need more specifications than a model for computer-mediated communication.

As such, Edwards and Middleton's model is a *reference (or generic) model*, that is, a general abstract model of memory, which describes generic knowledge about conversational memory processes. A step towards arriving at a model-for is to put content into the reference model; in other words to transform the reference model into a *content (or specific) model*. An imperative is that the content of the model be related to the content of use, and particularly to the situation(s) faced by users when working. To achieve the transformation I elaborated a situational approach I called the *Underlying-Situation Awareness Approach*, in reference to the now classical notion of "situation awareness".

III.2. THE UNDERLYING-SITUATION AWARENESS APPROACH TO MEMORY SYSTEM DESIGN

Definitions. — *Source situation(s)* refer to the situation(s) from which the reference model was elaborated. *Target situation(s)* refer to the situation(s) where the processes to be assisted by the system will take place. *Underlying situations* refer to both the source situation(s) and the target situation(s).

Motivation. — The *Underlying-Situation Awareness Approach* was motivated by what I learned from a design experience of a computer-supported cooperative work (CSCW) system where awareness of "underlying situations" reveals itself as crucial. The experience is Tatar, Foster and Bobrow's (1991) design of the CSCW tool *Cognoter.* Tatar *et al.* based their design on models of communication. The most influential was Clark and Wilkes-Gibbs' (1986) model of referential communication.

Conversational model of referential communication. The model describes how people participating in a conversation make reference to things with linguistic expressions such as noun phrases *(e.g., Take the spout—the little one that looks like the end of an oil can).* Clark and Wilkes-Gibbs called their model a "conversational model" in contrast with the at the time prevailing model which was mistakenly based on literary situations (*e.g.,* writing and reading novels, newspapers, and letters). This "literary model" embodied assumptions (*e.g.,* that speakers refer as if they were writing to distant readers) incompatible with the reference process actually carried on in conversation. Based on actual conversational situations, Clark and Wilkes-Gibbs' model incorporates more appropriate features, such as the *principle of mutual responsibility*[1] to which conversers are assumed to adhere. The model contains as an addendum a weakened version of the principle to account also for literary-like situations (*e.g.,* writing and reading E-mail messages), namely the *principle of distant responsibility.*[2] We can see yet from this description that the relevance of a model depends on the relevance of its (underlying) source situation. A *mis-situated* model will probably be less relevant not only to account for source situations, but also to inform the design of systems assisting target situations (see Giboin, 1996, 1998*a,* 1998*b*).

Using the model to design Cognoter. During the first design of Cognoter, Tatar *et al.* (1991) used an implicit model of communication they later called the *parcel post model.* This model proved incorrect when Tatar *et al.* performed user tests: the unexpected communication breakdowns that users encountered mostly stemmed from this model. Drawing mainly on Clark and Wilkes-Gibbs' (1986) *conversational model,* Tatar *et al.* elaborated "a more realistic model of the situation" their users faced (the target situation), and applied it to the system to understand the breakdowns. However, what Tatar *et al.* especially retained of the Clark and Wilkes-Gibbs' model is the "literary" principle of distant responsibility, because it seemed to them more adapted to their target situation. But they didn't find it completely adapted: strictly speaking, their target situation was neither literary nor conversational, but involved "a medium for representation in relation to the conversation" (p. 195).

1. According to which both speaker and listeners are responsible of listeners' understanding of reference.

2. According to which the addresser only is responsible of addressees' understanding of reference.

From the Tatar's *et al.* experience, I learned that: 1 / failures of systems to satisfy users may be sometimes attributed to the mis-situatedness of the communication model used as a design model, or to a lack of situation awareness from designers; 2 / in case of mis-situatedness, if designers want to improve their system, they need to replace the mis-situated model by a better situated one. These lessons led me to elaborate the *Underlying-Situation Awareness Approach*.

Main features of the approach. — The approach is grounded on the following principle: The design applicability of a model rests partly on the compatibility between the source situation(s) and the target situation(s). Consequently, if designers want to use a model, they need to be aware of the underlying situations; or they need to be sensitive to the contextual factors of the model they select, and to the compatibility of these factors with the contextual factors of the practices they want to assist. To assess model applicability, designers have to make explicit and to contrast the underlying situations, and to draw design consequences from the contrasting results (*e.g.*, accepting the model as such, adapting it, or replacing it). In other words, assessing the well-situatedness of a generic model is a way of getting a content model, and of ensuring the compatibility of the content model with the content of use.

Applying the approach to the design of a memory system. — When designing a memory system, we have also to consider the situation(s) in which remembering occurs. The reason is that remembering, as other processes or activities, besides to be purposeful, is *situated* : *e.g.*, within some interpersonal communication (Edwards & Middleton, 1986), or within some (collective) activity (Bannon & Kuutti, 1996; Kuutti & Bannon, 1996) as mechanical engineering design (Karsenty, 1996). Hence, if remembering is situated, a model of remembering cannot but reflect the situation in which it occurs. So if we want to use a model of remembering for design purpose, we need to be aware of its related underlying situations. Therefore I decided to apply the situational approach to assess the applicability of the conversational remembering model, trying to bridge the gap between a model-of and a model-for. As a result, I could be able to inform the design of a "conversational memory" system aimed at road accident analysts of DAMA.

Achieving applicability assessment requires to have a method allowing to make explicit the source situation(s) and the target situation(s), and to contrast them. This method will be reported in section V. Before, I will give an overview of the organizational site selected for the assessment.

IV. THE ORGANIZATIONAL MEMORY SITE

The site is one of the departments of INRETS, namely the Department of (Road) Accident Mechanism Analysis (or DAMA), located at Salon-de-Provence, France. The missions of DAMA are threefold : (1) analyzing the

dysfunctioning mechanisms which occur in the User[1]-Vehicle-Infrastructure (UVI) system, and which generate road accidents; (2) elaborating diagnoses as a means for avoiding dysfunctions and improving transport safety (primary safety, *i.e.*, what can be done to avoid crashes, and secondary safety, *i.e.*, what can be done to minimize crash effects and consequences); and (3) helping to design infrastructure, and vehicles, and to train designers, planners, and users.

The missions are achieved by teams of analysts, both formal and informal. These teams are pluridisciplinary, and they associate investigators (or "pre-analysts") and researchers (or "basic analysts") from diverse specialities covering the components of the UVI system. The specialists are infrastructure engineers, vehicle engineers, and psychologists (who could be called "user engineers"). Teams of investigators mainly perform missions (1), using EDA ("Étude détaillée d'accidents"), an "home-made" accident analysis methodology (see Ferrandez, 1995) which consists of the following steps:

1 / *Alarm* (t_0): When there is an accident, DAMA is immediately alerted by the Fire crew. Generally a team of two investigators is formed, and sent to the scene of the accident.

2 / *Investigation at the scene of the accident* ($t_1 < t_0 + 1/2$ h): Investigators operate along with emergency and state police units. One of them interviews the user(s) involved in the accident, while the other gathers transient information on the vehicle(s) and the infrastructure, taking photos of the vehicle(s), recording wheel-tracks, etc.

3 / *First scenario of the accident* (t_2): At the scene of the accident, or back at their office, the investigators exchange their first impressions of what happened, and discuss their initial hypotheses about the scenario of the accident. They determine which information is missing, so preparing another data collection.

4 / *Complementary data collection* (t_3 = 14 h to 18 h): Investigators mainly collect more permanent information at the scene of the accident again, or at other relevant scenes (*e.g.*, hospital, garage).

5 / *Structuring of data* (t_4): Investigators develop an accident report, filling in UVI check-lists and elaborating the accident synthesis (a kind of scenario); the report integrates also elements from dynamic and sequential analyses. Once structured, the report data are coded and electronically stored.

6 / *Analysis* (t_5): Investigators (initially researchers) identify the trajectory(ies) of the crashed vehicle(s) with ANAC, a simulation software (dynamic analysis), and determine the contents of the successive accident situations, that is, driving situation, accident situation, emergency situation, and crash situation (sequential analysis).

Missions (2) and (3) are mainly achieved by researchers, using the accident reports elaborated by investigators. More specifically, researchers perform "thematic analyses" on such topics as aged drivers' accidents, GTI cars accidents, crossroads accidents, and so on. Note that some researchers and some experienced investigators play the role of EDA supervisors, controlling investigators' work (*e.g.*, checking reports for consistency) and training new investigators.

1. *User* means user of the (road) infrastructure. He or she can be a driver, a pedestrian, and so on.

The first reason why I selected DAMA for applicability assessment is that the research team in which I am working (Acacia) collaborated with DAMA in two projects: the first one resulted in the acquisition of some expert knowledge necessary to road accident analysis (see Alpay, Giboin, & Dieng, 1998, Dieng *et al.*, 1998); the second project led recently to the design of "Reseda", an intranet system for assisting investigators in performing EDA. The second reason for selecting DAMA is that Reseda only partially supports the organizational memory of DAMA, and this partial support doesn't reflect the active remembering perspective. And yet, this perspective would be worth considering for designing a real conversational memory system for analysts, because analysts (as noticed during previous field studies of the DAMA site), communicate and cooperate very much through conversations, and that they jointly remember things during their tasks (things about the current accident, things about previous accidents, things about how they or their colleagues analyzed accidents in the past, etc.), so practicing a kind of conversational remembering. As a consequence, it appeared to me that one main aspect of assisting analysts was to support their activities of conversational memory. It seemed thus interesting to me to see if the "Conversational Remembering" model could be used to inform the design of a conversational memory system.

V. METHOD

DAMA site and Edwards and Middleton's model have been contrasted with each other, using the following method, which operationalizes the Underlying-Situation Awareness Approach.

V.1. DATA COLLECTION

Data sources were documents (in the broad sense) related to DAMA analysts and to analysis as practiced in DAMA. From these documents, I extracted elements describing memory tasks and activities.

Transcriptions of interviews. — The first type of documents are transcriptions of two series of interviews with ten analysts explaining their work. The first series of interviews was performed with seven researchers. The second series was performed with three investigators and one of the seven researchers (who was also a supervisor of investigators' work). The seven researchers were two user engineers (referred to as *Researcher-Psy-1* and *Researcher-Psy-2*), two vehicle engineers (*Researcher-Veh-1* and *Researcher-Veh-2*), and three infrastructure engineers *(Researcher-Infra-1*, *Researcher-Infra-2* and *Researcher-Infra-3)*. (Most of the researchers were former investigators.) The three investigators were two vehicle and infrastructure specialists (referred to as *Investigator-VI-1* and *Investigator-VI-2*) and a user behavior specialist *(Investigator-Psy-1)*.

Transcriptions of dialogues. — The second type of data sources are transcriptions of dialogues withing groups of two or three researchers who

were asked to analyze some accident case collectively, after having or not having analyzed the case individually. Group members had either the same speciality (*e.g.* vehicle engineering) or different specialities.

Field observation documents. — The third type of data sources are field observation documents, that is, written notes, sketches, photos, videos, and so on, taken and collected when observing teams of investigators in a real situation of accident report development.

Formal and informal documents from DAMA. — The fourth type of data sources are DAMA documents (notes, reports, articles, books, etc.) in which appear descriptions informing us about the collective memory processes performed possibly by analysts. One of these documents is "The detailed study of accidents directed towards primary security. Methodology of (data) collection and pre-analysis", a collective book reporting the EDA methodology (Ferrandez, 1995).

V.2. Data analysis

The goal of the analysis was to determine how well-situated the model was and the relevance of the model functions, and to orient towards model adaptations. This goal was achieved by performing a two-step qualitative comparison: 1 / contrasting the DAMA target situations to the Edwards and Middleton's source situation; 2 / contrasting the functions identified by Edwards and Middleton in the source situation to the functions which can be identified in the DAMA target situations.

Contrasting procedures. — *Situation contrasting* consisted of three stages: 1 / identifying the situations; 2 / identifying the required type of situation (in our case, conversations during which things are remembered); 3 / identifying other types of situations. Comparison of situations is based on the situation model presented below.

Function contrasting consisted of three stages: 1 / identifying the mnemonic functions implemented in the situations, and the structures involved in these functions; 2 / determining the functions which fit the model functions and those which do not fit; 3 / (when functions do not fit well or at all:) refining or complementing model functions (and related structures). Comparison of functions is based on the model of Conversational Remembering described in Section II.

Situation model. — Comparison of situations was performed through a model of the communication (or interaction) situation. The model used is borrowed from Kerbrat-Orecchioni (1990; adapted from Brown and Fraser, 1979). It decomposes the situation into two main constituents: the "scene" and the "participants"; these two constituents in turn decompose into sub-constituents which in turn decompose into sub-sub-constituents, and so on (see Fig. 2). The different constituents (or dimensions) of the communication situation are used as comparison criteria.

SITUATION	**Scene**	SETTING	*Spatial Setting* Physical Setting Social Setting *Temporal Setting*
		PURPOSE	*Maxi-Purposes* *Tasks* *Mini-Purposes*
	Participants	INDIVIDUAL FEATURES	*Biological and Physical* *Social* *Psychological*
		MUTUAL RELATIONSHIPS	*Degree of Mutual Knowledge* *Nature of the Social Link* *Nature of the Affective Link*

Fig. 2. — The components of an Interaction Situation
(adapted from Brown & Fraser, 1979; Kerbrat-Orecchioni, 1990)

Les constituants d'une situation d'interaction
(adapté de Brown et Fraser, 1979; Kerbrat-Orecchioni, 1990)

VI. REMEMBERING SITUATIONS

In DAMA, I did observe situations similar to the film-account situation of Edwards and Middleton, that is, people remembering together events they lived in the past. But I also observed situations more distant, and sometimes unexpected or marginal. I will overview the main differences between DAMA situations (or DAMAs) and Edwards and Middleton situation (or EMs) in terms of the situation dimensions presented in Figure 2.

Situation. — EMs is *unique*, whereas DAMAs are *multiple*. They can be found also at every step of the EDA process. They involve different participants, with possibly different purposes, and so on.

Participants. — In EMs, the group performing the remembering task is *homogeneous:* its members are first-year psychology students. In DAMAs, teams may be also *heterogeneous* (see section IV). Moreover, these teams may be enlarged with "foreign" members, or *outsiders*, for example: *(a)* during the intervention at the scene of the accident, the team of investigators is extended to users involved in the accident (drivers, passengers, pedestrians, etc.), witnesses (residents, rubbernecks), and emergency people (firemen, state policemen, ambulance men); *(b)* during the complementary data collection, investigators may have also conversations about

the crashed vehicles with garage mechanics and garage owners; *(c)* during the thematic analysis phase, researchers may have discussions with car manufacturers directly interested in improving the safety of their vehicles.

Spatial setting. — In EMs, participants remember their experience (the *E.T.* film) in a different place (a laboratory) from the place (a picture house) where they memorized the experience. In some DAMAs, participants may perform remembering in the same spatial setting where the accident took place. In EMs, participants remember through oral communication: they converse. However in DAMAs, analysts use also other kinds of communications such as written, graphical, or visual communications (*i.e.*, communications through sketches, check-lists, transcriptions of interviews, technical cards of vehicles, plans, photos, videos, etc.). For example, investigators may ask users to remember the accident by making them draw the event they have just lived through, or they may refer to the accident plan to elaborate a preliminary scenario of the accident (see Excerpt 1).

EXCERPT 1

Investigator-VI-2: [...] the most important is to make a fair copy of the plan. We will be able to discuss using a reliable scale, we can really see the length of the tracks, because when I make a sketch there is no scale [...], therefore with the result that we can imagine according to the scale if [...] [the user] really slowed down, or [that we can say:] "It's astonishing, you know, the trace he has! [...]"

In short, analysts' communications are not limited to "conversations", they are *multimodal.* We could however extend the meaning of the term *conversation*, as Schön (1996) did it to refer to "an interactive communication between [actors] in which the messages sent, received, and interpreted may take the form of words, actions, or objects" (p. 177). See also Kovalainen, Robinson and Auramaki's (1998) extended use of the notion of "dialogue", and De Michelis and Grasso's (1994) notion of "multimedia conversations".

Temporal setting. — In EMs, remembering takes place only once, over a short period (discreteness). In DAMAs, remembering can be repeated, and it can extend over a long period of time (continuity). For example, EDA steps may occur within a period of several days or weeks, and so may the related remembering activities.

Purpose. — In EMs, remembering is the main purpose of participants. In DAMAs, remembering can be also or mainly a *"secondary purpose"* (which depends on the purpose of the EDA tasks). In DAMAs the mnemonic activity can be accompanied by other activities, whereas in EMs it is the unique activity. In DAMAs, because current EDA purpose is different, so may be the purpose of current remembering (see Excerpt 2). EMs is primarily a situation of recall whereas DAMAs may involve also recognition and rearranging activities. In EMs, the "concern for accurate and dispassionate accuracy" of what is reported is not the concern of participants. It is the major concern of DAMA analysts.

EXCERPT 2

Researcher-Psy-2: [...] first the accident is something which is completed when we arrive [at the scene of the accident]. It is thus necessary to reconstruct the past [...] from traces, material traces and traces from memory [...] reconstructing is thus describing [...] what has occurred... and then, the higher level is to explain [...] why it occurred like that, to explain the links between the different events [...]

Degree of mutual knowledge. — In EMs, participants remembered a shared experience (the *E.T.* film). In DAMAs, participants *may not* all *experience personally* the same situation (the specific accident). For example, investigators do not share the accident experience with users. They do not remember exactly, but help participants remember. However investigators can be said to remember too, in the sense that they "co-memorate", and that when constructing the image of the accident, they use, for example, their knowledge of similar accidents, or their experience of users of the accident infrastructure, and so on (see Excerpt 3; see also Excerpt 5, Section VII).

EXCERPT 3

Researcher-Psy-2: [...] there it's in my memory, it's in my experience, which allows me to say like the driver said previously, "Well, I had never seen this" or to say, when someone gives me an explanation: "Well, this explanation is absolutley hare-brained, it's not true, I have never encountered this, it's a pure fiction, it's not possible" [...]

Social features. — In EMs, all the participants had the same status. In DAMAs, the participants' status can be different (*e.g.*, a supervisor has not the same status as an investigator); moreover, this status may change over time (*e.g.*, some DAMA researchers were formerly investigators).

Nature of the social link. — In EMs, group members can be considered as peers. In DAMAs, there are also hierarchical relationships, which determine analysts' activities; for example this can lead a superior to use the "authority argument" towards a subordinate (see Excerpt 4).

EXCERPT 4

Researcher-Psy-2: [...] I had some problems then with some investigator in the past [...] there were facts, material facts [...], indisputable, we agreed on the material facts, and we had to give an explanation, the explanation referred to the driver's mental state, to his representation of the situation in which he was [...] and this interviewer formulated a number of explanations, saying that, "In my opinion, [the driver] was thinking such or such thing, and he wanted to do such or such thing", and I said to him, "No, no, I rather think that [the driver] had such or such interpretation and that he wanted to do such or such thing, and [what you say] doesn't stand up", and he said to me, "But, it's your word against my word!" [...] and I said, "Yes, it is". [...]

Summary. — Table 1 recapitulates some of the differences between EMs and DAMAs. These differences determine the model applicability as we will see in the next section.

TABLE 1

Some differences between the source situation and the target situations

Différences entre situation source et situations cibles

Situation	*Edwards and Middleton's situation*	*DAMA situations*
Scene	Unique situation	Multiple situations
Spatial Setting	Oral mode	{Oral, written, graphical...} modes
	Mono-modal communication	Multi-modal communication
	Conversation	{Conversation, correspondence...}
Temporal setting	{Discrete} activity	{Discrete, continuous} activity
	Transitory	{Transitory, cyclic, repetitive}
	MT Memory	{ST, MT, LT, VLT} memory
	Synchronous communication	{Synchronous, asynchronous} communication
Purpose	Remembering = main goal	Remembering = secondary goal
	Recall	{Recall, rearrangement, recognition}
Participants	Homogeneous	{Heterogeneous, homogeneous}
	Group members	{Group members, "outsiders"}
Mutual knowledge	Shared experience	{Non shared, shared} experience
Social features	Same status	{Different status, same status}
Social Link	Peer	{Subordinate, peer, superior}

VII. REMEMBERING FUNCTIONS

At a general level, the main functions of Edwards and Middleton's model were found in DAMA situations. But, to take the situational specificities into account, it was necessary to adapt the functions, and to supplement them with other functions. Some examples of adaptations and completions are presented below.

VII . 1. Original functions of the model

I will begin with the second set of functions instead of the first one because I will suggest using the expression "correspondence functions" to refer to higher functions than the second set of functions, which I will call "translation functions".

Correspondence functions (henceforth translation functions). — The *semantic function* is limited in the model to *verbal* accounts (putting experience into words). A first adaptation to this function should be to extend it to *multi-modal* accounts (putting experience into words *and* graphics, photos, etc.). The function needs also to include not only accounts of some common experience, but also accounts of experiences which are not common or are partially common to the actors. Another adaptation concerns the fact that correspondences can be made between accounts expressed in various modes (*e.g.,* between a driver's interview and a photo), between a target experience (the actual accident) and similar experiences (other accidents), and so on. Excerpt 5 gives an example of such *experiential correspondences.*

Excerpt 5

Investigator-Psy-1: [...] yes, I work with my data and then we exchange [...] It's true that [*Investigator-IV-1*] drives a motor bike (and I also drove one) [...] you know some things that you cannot know [otherwise]... But it is more verbal exchange than really searching in old reports [...]

A more general adaptation could be to extend the term *correspondence* to denote : *(a)* some constituents of the other remembering functions, and *(b)* the relationships between what is done and thought by each participant (see our notion of *correspondence, i.e.,* the participants establishing and maintaining mapping relationships between their own representations and processes and the representations and processes of their partners; see Giboin, 1996, 1998*a,* in press). As a result of the generalization of the notion of "correspondence", I will suggest to replace the term "correspondence" in the expression "Correspondence functions" by the term "translation", previously used by Hayes and Flowers (1980) to refer to the writer's process of transforming retrieved, goal-relevant information into written sentences. Another function could be also extended to the whole process of remembering; this is the meta-comment sub-function. I will refer later on to this extension as the *meta-memory function* (see Section VII).

In a sense, translation functions are partially equivalent to the "enquiry mode", or *dialogue* function, defined by Senge (1990), where actors simply share facts, ideas, and viewpoints, without making any judgement (see below the complementary discussion function, or "advocacy mode").

Task functions. — The framing function can be adapted in various ways, or it can be split into different sub-functions (or modalities). Below are some examples of such sub-functions.

Between-activity framing. Framing concerns remembering as an embedded activity which depends on its embedding activity (as the EDA process in the case of analysts). Analysts need to establish a correspondence beween the embedding activity frame and the remembering frame.[1]

Within-activity framing. Analysts need also to establish correspondences between the frames activated at different steps (or moments) of the same activity. Let us illustrate this by Excerpt 6. The frames used to account for the accident during, for example, the two EDA steps (3) and (6) (see Section IV) are not the same. The difference appears in the definition of the term *accident* given by *Researcher-Psy-2.*

EXCERPT 6

Researcher-Psy-2: The accident, it's two things. There is the scenario, because it is a story: *I came from such side, I was driving at such speed [...]* And then, the accident, it's what happens to a system, which is in a certain state. And we describe the system. The system description, it's variables, the age, the sex [of the drivers], the kind of road, the width of the road, the administrative category [of the road]... if it is a straight line, or a curve, if there are shoulders [...], these are descriptors.

Adaptive framing. In some DAMAS, investigators adapt joint remembering frames to the user involved in the accident (see Excerpt 7).

EXCERPT 7

Investigator-Psy-1: [...] I'm there and it is a crossroads accident: it's a not-having-priority who engaged himself in front of an having-priority. The question I will ask to the not-having-priority will turn around information search, it's obvious. For the having-priority, [the question] will turn around expectations or around information search too.

Institutional framing. Frames used by investigators to reconstruct a particular accident are mainly institutional frames, that is, frames elaborated to be followed by the community.

Anti-framing. Analysts sometimes explicit frames or criteria not to follow in the remembering process.

Distant framing. In DAMAS, experience's accounts may "travel across space and time", and risk losing aspects of the original context in the

1. The safety science literature, which reports case studies and theories on design failures, near miss reporting, accident analysis, and so on, could be exploited to get more insight in the embedding activity of road accident analysts.

travel (see Brown & Duguid, 1996). To prevent contextual losts, actors may extend the *border* of the travelling objects. In terms of framing, this means that the "border" must contain sufficient information to allow the analysts coming later to retrieve the frame from which the account has been produced. Distant framing makes correspond the original (or distant) frame with the current frame. It appears in what *Researcher-Veh-1* pointed out when reading the contents of the first "generation" of DAMA reports, which contained only check-lists (see Excerpt 8). This analyst's comment supports also Bannon and Kuutti's (1996) claim that memory systems must allow access not only "to physical artefacts or records but possibly to the actors themselves" (p. 165).

EXCERPT 8

Researcher-Veh-1: It's difficult to understand the whole accident. It would be necessary to consult the person who did the study, because she knows much more of the accident, and she would succeed in reconstructing the accident.

Orientation function. As regards orientation, we should mention as an adaptation the management of orientation breakdowns (when the discussants are directed by a frame which is not that of the interlocutor). Concerning the task functions also, we should take account that discussants use multi-modal devices.

Validation functions. — Mnemonic consensus and plausible negotiation are crucial in the analysts' activities: analysts have to assess carefully the plausibility, completeness and accuracy of the accident accounts, because these accounts (esp. the accident reports) ground the analyses from which will be drawn important implications for transport safety, and for the design of new infrastructures and vehicles. Adaptations are again necessary there, for example:

Multiple-viewpoint validation. We have to take into account that validation functions are performed within *groups of different people*, either homogeneous (*e.g.*, groups of investigators only) or heterogeneous (*e.g.*, groups of investigators and users, groups of investigators and researchers). Group members often have different viewpoints. Validation is consequently performed through a confrontation of different testimonies or accounts of the accident experience, and through a confrontation of different versions of these testimonies and accounts. Argumentation takes a great part in the confrontation. Excerpt 9 illustrates this.

EXCERPT 9

Researcher-Psy-2: It was thus necessary to select the [accident] reports, the cases that we will keep to make a report, and the cases that we will reject. So, during all the week-end [...] investigators went to the scene of the accidents, and

collected information to make a report. Once, twice, three times [...] And on Monday morning, they came saying, "Well, we have six accident cases, which cases will we keep and which cases will we reject?" Then, we said, "Well, we will see... What are they about? Tell us the story of these accidents".

And the two investigators had to tell the other persons who did know [the accidents], "Here is [...] the story of the accident. And then we asked questions like, "But... why do you say that he brakes abruptly? [...]" Or, "Do you not believe that in fact he tried to [...] force his way [...]" [...] Then we tried [...] to review the different accident cases until the moment we said, "Well for this one... there is information that stands up, there are traces, the users look cooperating, cooperative, the quality of their information seems good, they correspond well to the traces [...] It will give an interesting and good report, we keep the case". [...]

In a sense, validation functions are similar to the organizational "advocacy mode", or *discussion* function, described by Senge (1990), where actors are "selling" ideas or positions, and try to come up with an idea that is going to achieve some kind of consensus (see also Middleton, 1996).

Correspondence devices for evaluation. The second example of adaptation relates to the multi-modality of the validation processes. This multi-modality is governed in particular by a basic principle of human memory. The principle is two-sided: 1 / for people to *encode* (or memorize) efficiently some information, they need to be projected in the situation where they would have to remember or to use the information; 2 / for people to *retrieve* (remember) efficiently some information, they need to put themselves in the encoding situation. Excerpt 10 illustrates the retrieval side of the principle (see also Excerpt 1, Section V, and Excerpt 11).

EXCERPT 10

Researcher-Psy-2: [...] there are accident types that I had practically never met... and about which I am quite embarrassed to develop a subtle questioning... example, the face-to-face [accident], I am quite worried, truck accidents also, and 2-wheel [accidents]... I am sure that there are interesting things to ask a motorcyclist. I have worked on accidents involving motorcycles, I had often asked for further information from my colleagues who are motorcyclists. For example, I always come back to *[Researcher-Infra-3]*, this guy is a gold mine because he has been a motorcyclist. He went away on holiday with his girl-friend behind, he crossed France, he went abroad on his motorcycle... Well, he was therefore able to understand a number of things, and he must explain them [...]

The retrieval principle leads us back to the principle of generalized correspondence. For the analysts, applying this principle results in the following attitude: to evaluate as correctly as possible the accident accounts, analysts put themselves or put others in the accident situation; they try to reproduce, or ask others to reproduce the original conditions, or similar conditions, of the accident situation. Several procedures or devices are used for that. Table 2 gives some examples of them.

TABLE 2

Some techniques for putting oneself or someone else "in the accident situation"

Quelques techniques pour se mettre ou mettre autrui "dans la situation d'accident"

Putting the user again in the situation
Putting the user again in the driving conditions
Driving afterwards with the user
Making the user do the route again
Making the user do some actions again (*e.g.* braking)
Putting oneself in the situation
Putting oneself in the vehicle's, user's and infrastructure's "shoes"
Making simulations
Simulating with toy cars moving on a scale-plan
Simulating with a test or experimental vehicle
Simulating with the ANAC reconstitution tool
"Action Replay"
Making some observation in a vehicle
Coming back through the scene of the accident with one's own vehicle
(Re)consulting documents about the current accident case
Replaying the video recording of a vehicle
(Re)reading the interviews of the current accident case
(Re)consulting documents about similar accidents
Consulting the report of a similar accident
Consulting photographs of vehicles crashed in similar accidents
Reminding
Recalling a similar accident case
Recalling one's own memories as driver
Putting one's colleagues in the situation
Making other investigators recall their own experience as drivers
Recalling colleagues' similar experience
Putting third persons in the situation
(Re)reading automobile tests in magazines (for similar vehicles)
Consulting witness reports on similar accidents

VII.2. COMPLEMENTARY FUNCTIONS

DAMA situations require us to add other functions to the model, which can be critical functions of the organizations. Some examples are given below.

Upstream functions. — Functions can be added upstream from the task functions, for example, *conditioning functions*. These functions are performed before the interaction; they allow participants to evaluate the conditions of the interaction, to set them up or to improve them if necessary, or to give up or postpone the communication. Upstream functions were sug-

gested by the analysis of investigators' behavior and of the DAMA collective book on EDA: investigators, before interviewing users, do indeed evaluate the conditions of the interviewing situation; they also take a number of precautions or adopt certain attitudes towards the users. Excerpt 11, picked up from EDA book, illustrates two interviewing weapons against possible biases in user's and investigator's "memory work".

EXCERPT 11

> The first and best weapon against these biases is to perform the interview as quickly as possible, *i.e.* at the scene of the accident. The second advantage of an investigation at the scene of the accident is to ask for a recall of the memorized [things] in the very context where these [things] have been memorized. The material setting contributes to memorizing, and facilitates the precise details.
>
> The second weapon is to stick to "how", before seeking to asking "why". The investigator may find it very beneficial to make people specify gestures, visual images, rough feelings, all things close to the concrete experience, before pushing the investigation to the "why", which is too easily skewed by mental reconstructions [...]

Conditioning functions thus allow analysts: *(a)* to determine the moment to start the interview (an injured party or a person whose companion was injured will not be questioned); *(b)* to adopt a positive attitude (the investigator must introduce himself, and should not put the participant in the position of culprit or fault); *(c)* to avoid possible reactions of rejection, so avoiding stopping the interview.

Downstream functions. — Functions can also be added downstream from the validation functions, for example, *storing functions*, as to record the accident account once validated (see, in Excerpt 9, the selection by analysts of the accident reports to preserve for a thematic analysis). The storing functions lead us to the distinction between remembering functions and memorizing functions.

Remembering functions and memorizing functions. — Due to a methodological choice, Edwards and Middleton (1986) focused on the "retrieval side" of memory, and they leave out the "encoding side" almost entirely. Because DAMAs involve both remembering *and* memorizing situations, encoding functions must be added to the model. This is an important issue from the organizational point of view, because organizational memory includes both these sides (see Bannon & Kuutti, 1996).

Recalling functions and recognizing functions. — In EMs, people *recall* some experience. In DAMAs, investigators may also recognize, for example, the traces of the current accident among traces left by former accidents on the same road. So recalling functions and recognizing functions (and even *rearranging* functions) can be distinguished in the model.

Meta-memory functions must be developed to take account of such activities as, for example, anticipating a retrieval setting, and preparing for it (see the meta-functional activities of Falzon, Sauvagnac, & Chatigny,

1996): analysts are now well aware that the information they "initially produced and stored" will be "subsequently interpreted and understood by other people, in other settings, at other times" (see Bannon & Kuutti, 1996), and they create devices allowing them to produce and store information in a way compatible with later retrieval or re-use (see correspondence functions).

Learning and experience. — People learn to remember too. They get experience in the activity of remembering. This learning function does not appear in the 1986 model of Edwards and Middleton.[1] Analysts are directly and indirectly trained to remember. For example, new investigators are trained to overcome memory problems related to interviews (see Excerpt 11). Analysts also learn by experience, and often from each other (see Excerpt 12).

EXCERPT 12

Researcher-Infra-3: [In DAMA] there are psychologists who are practically engineers and engineers who are [practically psychologists]... There is an engineer [...] his name is *[Researcher-Infra-1]* [...] he is currently working on perception problems [...] he submitted some photos and pictures of infrastructures to a number of "guinea-pigs" in a certain order, [...] [and he] ask[ed the "guinea-pigs"] what they would expect to find in [the infrastructures]: which type of bend, which types of road-sign, to see a little bit how consistent the road installations can be. [...] Well, [these are] perception analyses [...] it is very... psy[chological], eh?, whereas he is an engineer... And then, conversely, there is [...] a psychologist... who works quite a lot with us [and] who [...] is in the know about vehicle problems, ABS use, emergency operations, who specialized in that.

A model of memory should also give an account of the learning functions used by organization members, or it should be complemented by a model of organizational learning, such as Senge's (1990). Senge emphasizes the importance of conversation, especially in team learning. He claims that an efficient team is able to carry out "learningful" conversations that balance inquiry (dialogue) and advocacy (discussion), where actors expose their own thinking effectively and make that thinking open to the influence of others.

VIII. REMEMBERING STRUCTURES

Mainly concerned by which functions are performed during remembering, Edwards and Middleton (1986) did not develop the question of which structures underlie memory functions. Because the functions actualized in the DAMAs cannot be fully understood without a deep knowledge of these structures, it will be necessary to give more emphasis to the structural aspect of memory in the model. This means that we can give again some place to the "passive storage" perspective, and "consider organiza-

1. It appears however in later work (see, for example, Edwards & Middleton, 1988).

tional memory as both object and process" (Ackerman & Halverson, 1998, p. 47). I will discuss the question of structures from two angles: 1 / mental and physical structures; and 2 / situational structures.

VIII.1. Mental and physical structures

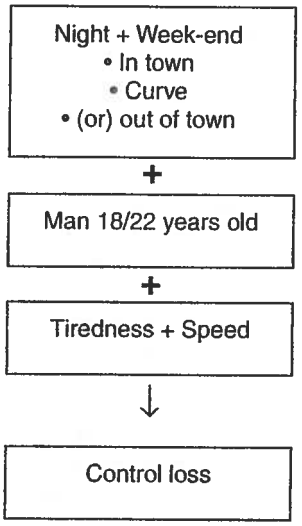
Remembering is oriented and molded by mental and physical structures. These structures include internal as well as external representations of states of affairs. Internal representations (*e.g.*, frames, schemas, mental models, images) are potential functions that have to be actualized to lead to their corresponding behaviors. External representations (*e.g.*, photos, maps, computer tools) are objects and artifacts that mediate behavior. External (internal) representations are internalized (externalized) in particular through conversation.

Frames. — Conversational remembering, Edwards and Middleton observed, is guided by structures they called "discursive frames" (*e.g.*, narrative, affective reminiscence). It would be necessary to give more indications about the external representation of frames as well as about their internal representation. It would be also necessary to make a distinction between "synchronous remembering" frames and "asynchronous remembering" frames.

Edwards and Middleton's frames are very few, simple, and form part of knowledge common to the majority of people. They thus do not need to be clarified by participants. On the other hand, the frames used in DAMA "to tell" about the accidents are comparatively numerous, sometimes complex, and rather refer to specialized knowledge. We can include in this specialized knowledge generic representations mentioned earlier such as the UVI model (see section IV), the situation model of the accident (see section IV), the functional model of the user, and "generic scenarios". These specialized representations should be explained too by the model of memory, because they provide analysts with a source of questions, together with frames for describing, understanding, and remembering the accident (wrong or unsuitable representations should be also considered, because analysts have to deal with too). Generic scenarios are worth illustrating here.

A generic scenario (also called "prototypical scenario" or "scenario type") synthesizes the characteristics common to a set of similar accidents. An example of such a scenario is given in Figure 3. One main interest of researchers from different specialities is to produce such scenarios. For example, *Researcher-Infra-1* and his collaborators elaborated taxonomies of generic scenarios of accidents between vehicles circulating on various infrastructures within different regions of France (the example given in Figure 3 is one of these scenarios). *Researcher-Psy-1* and his collaborators elaborated also another taxonomy of "scenario types" of production of human error in road accidents. Searching for a mutual agreement on generic scenarios, some researchers elaborate also "consensus scenarios" (see Després, 1998). This leads us back to conversational remembering functions. (For details on the various DAMA frames, see, for example, Alpay *et al.*, 1998; Després, 1998; Dieng *et al.*, 1998; Ferrandez, 1995.)

Graphical representation



Textual representation — A young man driving at night fast, a week-end, while being tired, risks losing control of his vehicle.

Fig. 3. — (Simplified) generic scenario "Young driver-vehicle alone"
Scénario générique (simplifié) « Jeune conducteur – véhicule seul »

Note that works on multiple representations (see, *e.g.*, van Someren, Reimann, Boshuizen, & de Jong, 1998) could help specify these structural aspects of remembering (see other references below).

Artifacts. — When remembering, analysts make a great use of artifacts. Investigators, for example, use test vehicles, toy vehicles, and the ANAC (vehicle trajectory) simulation software to perform the validation functions. Excerpt 13 illustrates the use of miniature vehicles together with an inking-pad to determine the trajectories of a vehicle. DAMA practices thus confirm the idea that remembering is "something which occurs in a world of things, as well as words", and that "artefacts play a central role in the memories of cultures and individuals" (Radley, 1990, p. 57). DAMA practices also corroborate the idea that organizational memory is an "artefact mediated process" (see Kovalainen *et al.*, 1998).

EXCERPT 13

Researcher-Infra-2: We worked very often with an inking-pad and a scale vehicle on a paper sheet, very crudely, that is to say, one should not be afraid to make very simple things. Therefore you take a scale vehicle, you place it on an inking-pad and you already start to see...

Edwards and Middleton's model does not account of how external representations other than verbal devices determine the memory process. Because DAMA external representations are an integral part of the actual process of remembering, Edwards and Middleton's model needs to be adapted to account for these representations. To perform the adaptations we can use existing works on external representations, such as Norman's (1993) work on "cognitive artifacts", or Ostwald's (1996) work on "representations for mutual understanding", in the spirit of what we have done in a study of multiple representations used by road accident analysts (see Alpay *et al.*, 1998). Other works are also worth considering, such as, among others, Kovalainen *et al.* (1998) work on "artifact format" (to account for the frames used for asynchronous communication), Cole and Engeström's (1993) work on "cultural artefacts", and Wertsch's (1998) related work on the role played by "cultural tools" or "mediational means" in human action (to account for corporate representations such as consensus scenarios). All these works emphasize that organizational remembering is an "artefact mediated process".

VIII.2. SITUATIONAL STRUCTURES

In this paper, I hold the idea of situated remembering (or "situational remembering", Kuutti & Bannon, 1996), that is, of a memory activity which depends on the elements of the situation in which it occurs (or underlying situation). So that we could include in the structures which determine remembering what I will call *situational structures*, that is, structures which describes the components of a remembering situation, as well as their relationships. To help situate the remembering process, a remembering model must be based on, or it should integrate such situational structures. These structures could take various forms related to the different approaches to activity analysis, for example, situated activity theory, (cultural-historical) activity theory, and distributed cognition theory (these approaches are in fact complementary, and sometimes integrated, as in Cole et Engeström, 1993). I will refer to these structures with the name of their underlying approach.

"Situated activity" structure. — A situational structure defined from the situated activity perspective could contain components of situated-activity theories (*e.g.*, activity, tasks and encounters). The structure could be based also on the model of communication situation used in the present study, or on similar models, such as the "Speaking" model of Hymes (see Kerbrat-Orecchioni, 1990), the context model of Clark (1992), or the situation model of van Dijk (1996).

"Cultural-historical activity" structure. — A situational structure defined from the related (cultural or social historical) activity theory perspective, could be grounded on the "pyramidal" model of Engeström (see, for example, Cole & Engeström, 1993), and its seven inter-related elements (subject, object, outcomes, mediating instruments, community, division

of labor and rules). Kuutti and Bannon (1996) used Engeström's model to elaborate one of the two dimensions of a framework for supporting and situating "situational remembering" (the other one being "remembering modality": past, present, future). To specify "division of labor" aspects of a remembering situation, we could also refer to the conversational remembering roles (*e.g.*, narrators, mentors and monitors) observed by Manier, Pinner, and Hirst (1996).

"Distributed activity" structure. — From a distributed cognition perspective, a situational structure must reflect that remembering is distributed among various persons and groups of persons, artefacts, and so on. Ackerman and Halverson (1998) showed that organizational memory is even "complexly distributed". Stein and Zwass (1995, p. 88), as well as Walsh and Ungson's (1991), view organizational memory as distributed "throughout the entire organization and beyond its boundaries". I will say more generally that situational remembering or memory is potentially distributed among the different components of a situation. If we take, for example, Engeström's model of activity structure as a model of situation, we could say that remembering is distributed among instruments (artifacts), rules and among people according to the division of labor (see Cole & Engeström, 1993). And if we take Kuutti and Bannon's temporal dimension of their framework, we can say also that memory is distributed among past, present, and future people and artifacts.

IX. IMPLICATIONS FOR DESIGNING A MEMORY SYSTEM

What are the implications of the present applicability assessment for the design of an "active memory" system aimed at road accident analysts (and more generally for the design of a conversational memory system)? I will give some examples of implications,[1] mainly in terms of requirements: 1 / for the functions (and structures) added to the Edwards and Middleton's model; and 2 / for the original functions of the model.

Learning and meta-memory functions. — The system would allow analysts to capitalize their collective experience on accident analysis, and to reflect upon their remembering conversations to improve them. More specifically the system could help: *(a)* store experience on corporate frames (the frames that are recommended by the institution), and not recommended frames; *(b)* elaborate new collective frames (as consensus sce-

1. Note that the nature of the implications will differ, depending on the position we can have about the conversational status of the system (cf. Luff, Gilbert, & Frohlich, 1990). If we assume that the system, like human actors, use (even "weakened") intentional and interpretational processes, we will consider the system as a "conversational partner". If we assume on the contrary that the system does not use such processes, we will consider the system as behaving like a mediating instrument between the actor (subject) and his intentions/interpretations (object) (see Cole & Engeström, 1993).

narios); *(c)* keep track of misuses of recommended frames, and of uses of not recommended frames; *(d)* explicit frames used in various analyses; and *(e)* discuss on conflicting frames. The system could also analyze conversation tracks automatically and learn from these analyses.

Upstream and downstream functions. — The system could help analysts prepare next conversations, continue long-extent conversations, resume conversations, foresee future conversations. In particular it could provide assistance to the following tasks: distributing remembering functions and roles throughout the various "components" of the situation (actors, artefacts, etc.); finding the "right" conversers (when conversation participants are not determined); getting information on present and past conversers (when they are not or not well known); setting the type of remembering to be done (*e.g.*, remembering/memorizing or recalling/recognizing); recording conversations (or what needs to be kept of the conversations; see design rationale); learning from the current conversation; record further information necessary to future conversations.

Correspondence functions. — The memory system could help establish and maintain the correspondence between the representations and processes of organizational members, mainly for asynchronous remembering situations, where actors have to communicate with past and future, or absent, actors. For example, the system must contain sufficient information to allow the analysts later joining the conversation to retrieve the frame from which the accident account was produced (see "distant framing"). This implies that the system prompts analysts to explicit, or comment, the frame they use to help the analyst who "resumes" the (asynchronous) conversation to be on the same wavelength.

The system could in fact represent a "place for correspondence", or a "common meeting ground" (a kind of common information space, Schmidt & Bannon, 1992), prior to establishing the common ground necessary to mutual understanding (Clark, 1992) and mutual agreement (cf. Alpay *et al.*, 1998). The structure of this place could reflect partially the situational structure. To the meeting ground would be linked *tools for correspondence* (see Giboin, 1996, 1998*a*, 1998*b*), for example, terminological (and even meaning) correspondence tables to assist mutual understanding, and devices for establishing correspondences between frames. The devices would allow for example to disclose and solve frame dissonances. The system would also provide tools for orienting towards non computerized tools and procedures for putting oneself or putting others in the accident situation (see validation functions).

Remembering/memorizing and recalling/recognizing functions. — The system would provide facilities for storing accident accounts, and for indexing them for later retrievals. The system would also help recognition activities, for example, by providing repositories of "things" related to accident situations (as photos or videos of roads, vehicles, etc.), or by referring to these "things" when they are not yet or cannot be "virtualized".

Task functions. — The system could assist framing and orienting the task at hand. For example, it can help establish remembering criteria, provide organizational frames *(institutional framing)*, warn against not recommended frames *(anti-framing)*, remind rules for using frames, provide questions related to frames (so improving effectiveness of frame use), show the frames used in previous conversations *(distant framing)*, moderate the negotiation of the frame to be used in the current discussion (or refer to a human moderator), manage orientation breakdowns (*e.g.*, disclosing frame dissonances) (see meta-memory and correspondence functions).

Translation functions. — Translation functions, especially the semantic one, are not very easy to assist as they need a great interpretational work. If we think of the system as a conversational partner, the system could integrate interpretational and intentional facilities such as the ones that can be found in some intelligent interactive systems. If we think of the system as an artefact mediating between conversers and their "objects", the system could provide facilities such as helping the user put experience into multiple representations such as words, graphics, images, photos, videos, and so on (in other words helping the user to generate *multi-modal* accounts of the accident); providing multi-modal representations; "virtualizing" (*e.g.*, scanning) the representations when they are not yet virtualized; ordering the representations according to the selected frame; integrating multi-modal representations into one place; translating external representations into meanings (*e.g.*, by referring to images); revealing different meanings for a same representation (to overcome possible misunderstandings); delegating interpretation to a human actor; finding human "correspondents" who can give the actual meanings that original actors had in minds. Assisting translation functions could be seen also as assisting the "dialog function", or "enquiry mode", defined by Senge (1990).

Validation functions. — Mnemonic consensus and plausible negotiation could be assisted in differents ways; for example, with functionalites similar to the facilities available in computer-supported collaborative argumentation: argumentation notation and representation (based on hypermedia and multimedia), consistency checking of accident accounts, argumentation traceability, reminding criteria established during the task framing phase, and so on. Assisting validation functions could be seen also as assisting the "discussion function", or "advocacy mode", defined by Senge (1990). All this means that conversation, or more generally interaction and cooperation, would be a core element of an "active memory" system.

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ABSTRACT

Designers of organizational memory support systems sometimes want to use existing academic models of memory to guide the design of their systems. This paper claims that for system designers to assess how applicable is a model of collective memory for system design, they need to be aware of: 1 / the situation(s) from which the components of the model have been elicited (the source situations); 2 / the situations to be "assisted" by the system (the target situations); and 3 / the compatibility between the source situations and the target situations. It is referred to this as the "Underlying-Situation Awareness". An approach allowing this kind of awareness is presented, namely the Underlying-Situation Awareness Approach. The use of this approach is illustrated by contrasting the Edwards & Middleton's (1986) model of conversational remembering with the practices of analysts' teams in the Department of Accident Mechanism Analysis of INRETS (the French National Institute for Transport and Safety Research). This situational contrasting leads to some adaptations to the original model. In turn, the adapted model enables to draw implications for the design of a conversational memory system.

Key words: *Collective Memory, Organisational Memory, Conversational Remembering, CSCW, Situation Awareness.*

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