Human-Computer Interaction -- INTERACT'03
M. Rauterberg et al. (Eds.)
Published by IOS Press, (c) IFIP, 2003, pp.65-72

Questioning the effectiveness of contextual online help: some alternative propositions.

Antonio Capobianco
LORIA
Campus scientifique, BP 239
F54506 Vandoeuvre-lès-Nancy
France

Antonio.capobianco@loria.fr

Abstract: Most online help systems on the market prove unsuited to the actual needs of novice users. Although recent research has focused on the design and implementation of contextual, adaptable or adaptive, help systems, the actual effectiveness and usability of such systems has not yet been assessed extensively.
We present an experimental ergonomic evaluation of a contextual help system implementing human expert strategies. 18 potential users interacted with a standard text processor, using two help systems, a contextual one versus a non contextual one. Each system was simulated using the Wizard of Oz paradigm. The contextual help strategies were defined from the analysis of novice-expert dialogues.

Contextual help proved more effective than non contextual help as regards successful task execution, this result being statistically significant. Concerning the influence of individual cognitive characteristics on the subjects' performance, analyses based on psychological tests suggest that contextual help facilitates message understanding, whereas it is less effective than standard help for subjects with low exploratory capabilities.

Keywords: Online help, procedural information, usability evaluation, human-computer interaction, human expertise elicitation, wizard of Oz.

1 Introduction

Most state of the art online help systems prove unsuited to the actual needs of novice users, and fail to help them effectively. After a few attempts, novices usually tend to ignore them. However, these systems often represent the only help support novice users can refer to. Thus, achieving effective online help is a challenge to be taken up for implementing universal access to the information society (Capobianco and Carbonell, 2002).

Recent research has focused on the design of adaptive help systems in order to address this issue. Most efforts have been centred on the design of contextual help systems, as this represents an attractive research direction, given its potential regarding error detection and correction, strategic didactic support and user centred adaptation (Coombs and Alty, 1980 ; Moriyon, Szelkely and Neches, 1994 ; Mallen, 1995).

However, few studies have focused on the assessment of the actual utility and usability of contextual help systems.

The empirical and experimental work presented here attempts to investigate the influence of contextual, versus non contextual, online help on the efficiency of novice users' interactions with a standard application software, and on their learning of the software operation. This study is based on a bottom-up approach.

We first analysed a set of real dialogues between novice and expert users so as to elicit and model the help strategies used by the experts (Capobianco and Carbonell, 2001). Then, in order to evaluate the effectiveness of the strategies identified, we designed and performed a Wizard of Oz study involving two 'wizards'. Wizards were assisted in the simulation of the human experts' help strategies by specific software tools (developed in Java) that constitute the key modules of a software implementation of these strategies.

2 Related research

New information and communication technologies transform the human activities they support, at least they change our comprehension of these tasks (Berg, 1997). In order to master human-computer systems, users have to adapt to continuous software evolution. They have periodically to apply new procedures for carrying out customary tasks. The constant evolution of execution procedures implies continuous learning.

To be efficient, online help systems must encourage such learning while allowing users to develop strategies that meet their individual needs (Pejtersen and Rasmussen, 1997).

Thus, online help systems must help users to (Duffy, Mehlenbacher and Palmer, 1989):

- elaborate an appropriate context to the use of the software;
- learn how to fulfil their goals by using it;
- acquire the skills to manipulate it efficiently.

2.1 Online help specific design issues

Consulting help material in electronic form leads to specific usability problems. In spite of the numerous advantages of multimedia systems, lower user performance has been observed with online help support compared to paper help. Specific solutions are needed to facilitate and enhance interaction (Cohill and Williges, 1985). To ensure efficient support, online help systems ought to provide users with adapted access to usable help information.

In order to achieve this goal, several approaches have been experimented, based on advances in various fields: databases (Borenstein, 1985 ; Roestler and McLellan, 1995), hypermedias (Edwards and Hardman, 1989) and multimodal information presentation (Palmiter and Elkerton, 1991 ; DeVries and Johnson, 1997). These approaches contribute to provide users with intuitive and easy search or navigation in large help information repositories.

However, these approaches provide only ‘static’ access to help information; they neither take account of the evolution of users' skills and intentions during interaction, nor take advantage of available contextual information for helping them to carry out tasks. Recent research has brought out the usefulness of context sensitivity for implementing ‘dynamic’ help that could assist novice users in overcoming the specific difficulties they are confronted with (Carenini and Moore, 1993 ; Quast, 1993 ; Mallen, 1995).

2.2 Potential contributions of context sensitivity

Context sensitivity subsumes several features. It implies adaptability to the current user individual characteristics, that is his/her general knowledge and skills, motivations and objectives (Breuker, 1990). Adaptable systems attempt to implement access methods or information selection support tailored to the actual needs of users, to their motivations and/or skills, using 'static' contextual knowledge (Bach, 1991 ; Roestler and McLellan, 1995).

Context sensitivity also includes sensitivity to the actual current goals and needs of the user (Coombs and Alty, 1980). This ‘dynamic’ knowledge proves useful for solving many problems encountered by novice users; for instance, error recognition and correction may be facilitated by comparing the actual state of the system with the state that should be reached to fulfil the user's current goal (Wilenski, 1984 ; Dzida, Hoffmann and Valder, 1987 ; Quast, 1993). This example brings out the usefulness of continuous awareness to the current state of the system for ensuring ‘dynamic’ context sensitivity. In particular, such contextual knowledge is necessary for generating help messages consistent with the system current state and the actions that can be performed to modify it (Tattershall, 1990).

In spite of the potential of design approaches implementing adaptability or adaptivity, few studies have attempted to apply these concepts to the design of online help systems. Moreover, the efficiency of the resulting help systems and their impact on the end user have not yet been assessed thoroughly, at least to our knowledge. The research presented here aims at filling in this gap.

In the remaining of this paper we report some empirical and experimental results stemming from the analysis of human experts' contextual help strategies and the ergonomic evaluation of a context sensitive simulated help system. The contextual information considered in this research mainly includes awareness to the user's current intention(s) and the system current state.

3 Elicitation and implementation of human experts' help strategies

Assuming that human help strategies are most effective (see the experimental results presented in Borenstein, 1985), we defined the strategies of the contextual online help system whose effectiveness and usability we meant to assess experimentally later on, from the analysis of the behaviours of human experts.

3.1 Human experts' help strategies

We analysed a set of 15 oral dialogues involving 2 human experts and 15 novice users. The role assigned to the experts was to help the novices to carry out 19 text processing tasks using MS Word.

Each speech act in the dialogues was characterised using, for the novices, criteria stemming from published taxonomies (Pilkington, 1992 ; Roestler and McLellan, 1995) and, for the experts, an ad hoc taxonomy established from a preliminary survey of the corpus. This taxonomy, which mainly characterises the contextual information actually used by the experts, distinguishes 5 context classes: the user's current action (CA) and intention (CI), the system current state (CS), the interaction background (IB) [i], and the progress of the ongoing task execution (RS). The analysis of the experts' speech acts using this taxonomy yielded results that are summarised in (Capobianco and Carbonell, 2001) and fully detailed in (Capobianco, 2002) [ii].

Briefly, these results indicate that the type of contextual information the experts used most frequently is the progress of the ongoing task execution: they made use of RS information in 71% of their speech acts (see figure 1).

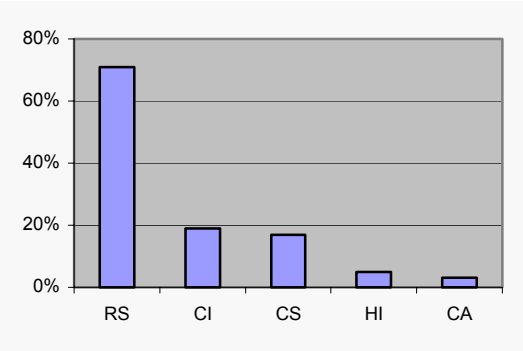

Figure 1: Type of contextual information used by the experts. Percentages have been computed over all the experts' speech acts.

RS information is used by both experts to provide subjects with opportunistic contextual help based on a hierarchical decomposition of the ongoing task. Help information is delivered step-by-step, that is: for each step in the execution procedure of a complex task, the information needed to carry out this step is provided only after the previous step has been completed (see figure 2). The help messages at the root of the tree point out the relationship between the user's goal and the function/procedure in the software that has to be executed to achieve it.

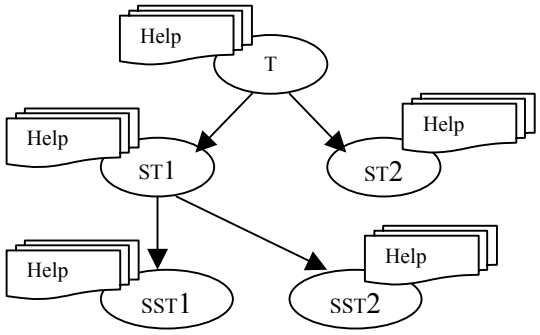

Figure 2: Task decomposition into sub-tasks with associated help messages. For instance, T = "Text centring", ST1 = "Text selection", ST2 = "<Centring> icon activation", etc.

3.2 Implementation of the experts' help strategies

We developed a software tool meant to assist human operators in the simulation of the help systems that were to be involved in the experimental ergonomic evaluation of the experts' contextual help strategies.

The text processing tasks subjects had to carry out were decomposed into simple sub-tasks, using the GOMS model (John, 1990 ; Kieras, 1996). Appropriate help messages (textual and graphical HTML messages) were associated to each task and to each sub-task in the tree representing the task. Several messages were associated to each node, one per class of help requests in our taxonomy. The wizard's main activity was to interpret the subjects' oral requests. To answer them, he had only to select and activate the appropriate sub-task node in the displayed task tree, the associated message being automatically sent and displayed on the subject's screen. Occasionally, he had also to select and activate the tree representation of a task corresponding to the user's new current intention.

This tool also saved the trace of the interactions between both simulated help systems and the subjects.

4 Evaluation protocol

[i] IB refers to the traces of the expert-novice dialogue and the novice-software interaction.

[ii] Capobianco, Antonio (2002). Stratégies d'aide en ligne contextuelles : Acquisition d'expertises, modélisation et évaluation expérimentale. PhD Thesis, Université Henri Poincaré, Nancy, France.

We designed an experimental comparative study where subjects used successively (in counterbalanced order) two simulated online help systems, a standard non contextual one (NCH), and a contextual one (CH) implementing the experts' strategies. Message contents only varied from one system to the other.

4.1 Experimental set-up

18 voluntary subjects performed 18 text processing tasks using MS Word. Help messages appeared on an adjunct dedicated screen in answer to their oral requests which they could express without any linguistic or enunciation constraint.

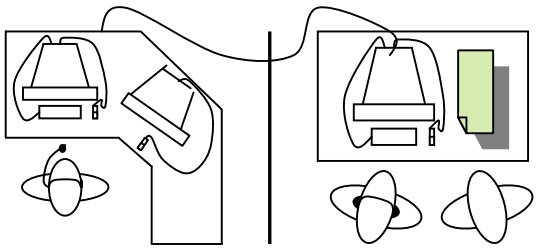

Figure 3: Experimental set-up.

These requests were transmitted to 2 wizards through a microphone. One wizard was in charge of the activation of help messages while the other observed the subject's interactions with Word and described them cursorily in written form.

Subjects' oral requests, task execution times and results were also recorded.

4.2 Subjects' profiles

All subjects were first year undergraduate students with the same background knowledge and a very superficial and limited familiarity with MS Word.

In order to analyse the influence of individual cognitive characteristics on the effectiveness of each help strategy, we resorted to two cognitive factors: the g-factor or general intelligence factor (Spearman, 1927), and the field dependence/independence factor (Witkin, Oltman, Raskin and Karp, 1971 ; Goodenough, 1976). These cognitive characteristics were chosen because of their possible significant influence on users in interactive help situations.

We used the BLS 4 test to evaluate the g-factor (Bonnardel, 1970), and the GEFT test (Group Embedded Figures Test) to evaluate field dependence (Witkin, Oltman, Raskin and Karp, 1971).

5 Analyses and results

To analyse subjects' performance we resorted to three criteria that were applied to any or both help situations:

- the percentage of tasks performed successfully (TPS) by the subjects;
- the percentage of tasks they performed optimally (TPO), that is using the most efficient strategy and procedure, in particular without resorting to a trial and error strategy.
- for each task, the average execution time.

5.1 Performance

Main results stemming from the comparisons between both help situations show that contextual online help leads to better performance than non contextual help, both with respect to the first (TPS) and the second (TPO) criteria; see figure 4.

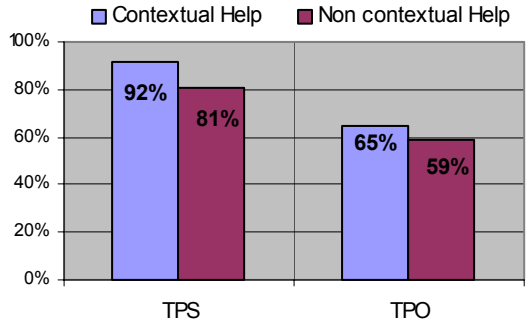

Figure 4: Performance comparisons: contextual versus non contextual help.

Statistical analyses (t-tests) indicate that differences in performance between the CH and NCH situations are significant for TPS ($p = .041$), but not for TPO ($p = .217$).

However, the gain of performance in the CH situation being relatively small, we refined analyses and comparisons to obtain more meaningful results.

5.2 Cognitive load

To evaluate the subjects' cognitive loads we compared average task execution times for the CH and NCH situations.

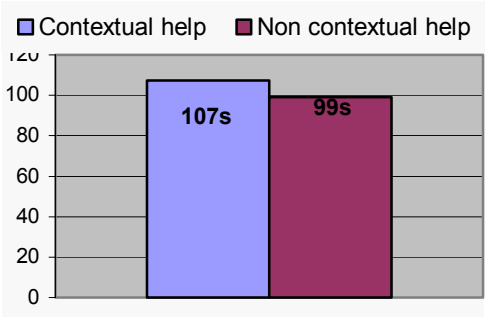

Figure 5: Average task execution times (in seconds) for both help systems.

Results in figure 5 show that average task execution time (third criterion) is greater in the CH situation than in the NCH one. This result suggests that contextual online help is less efficient in terms of speed than non contextual help. The fact that, in the contextual help system, a sequence of messages was associated with each complex execution procedure (one message per execution stage), whereas, in the non contextual help system, only one global message was associated with each procedure, may explain this difference. Therefore, there is no clear evidence that contextual help is cognitively more costly to use than non contextual help, all the more so as the difference between the two percentages in table 5 is less than 10%.

However, further research is needed to ascertain whether or not the use of contextual help has a higher cognitive cost than the use of non contextual help. Any additional cognitive cost could be detrimental to users with low cognitive capabilities, especially in the context of highly demanding cognitive activities.

5.3 Influence of task knowledge

We classified the 18 prescribed tasks according to the subjects' average [iii] performance for each task, assuming that average performance is indicative of task execution difficulty. For each task, we also defined another indicator (TPST) as the percentage of successful executions in each situation.

Our results show that the gain in performance observed in the CH situation compared to the NCH situation is strongly correlated with task difficulty (see figure 6). It increases from 0 for easy tasks to 80% for difficult tasks.

[iii] computed over the results obtained with both help systems for each task.

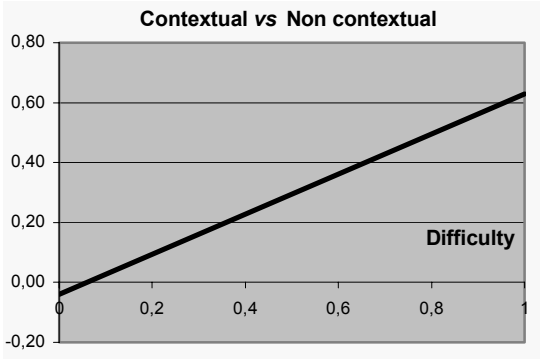

Figure 6: Correlation between gain in task performance, and task difficulty.
Gain = $TPST_{CH} - TPST_{NCH}$

Besides, as the difficulty of a task is by definition linked to the familiarity of the user with this task, the results in figure 6 lead to the conclusion that the efficiency of contextual help compared to non contextual help is greater for the tasks users are less familiar with.

According to this finding, flexible help strategies are likely to prove most effective, namely strategies that provide users with either contextual or non contextual help, according to their familiarity with the current task. To implement such a strategy, help systems have to be able to initialise and update a dynamic model of the current user's knowledge of the software operation, and to deduce, from the current state of this model, the type of message to generate in answer to the user's current request: several contextual messages (one for each step in the procedure), or a unique non contextual one.

5.4 Influence of cognitive profiles

The ***GEFT*** (see section 4.2), which we used for assessing field dependence, is meant to evaluate the ability to perceive an object in a visual scene and isolate it from its context. According to (Huteau, 1979), GEFT results are correlated with the capacity to solve problems using an analytical strategy.

In the context of human-computer interaction, this test has been used to characterise interaction styles (Coventry, 1989; Dufresne and Turcotte, 1997): higher scores characterize users who favour exploration, whereas lower scores denote reluctance to exploration, together with an aptitude for processing linear directions efficiently.

The ***BLS4***, currently used for evaluating the g-factor, provides a global assessment of the mental faculties that make up intelligence and, therefore, are involved in most cognitive activities (Spearman, 1927). We used it to assess the subjects' capability to understand help messages, that is to interpret and

carry out the instructions included in them accurately.

Results in table 1 and 2 show that some of the cognitive characteristics evaluated by these tests had a noticeable influence on subjects' performance.

Task execution:	Successful	Optimal
GEFT test	**p = .00581**	*p = .06220*
BLS4 test	**p = 9.82 E-05**	p = .14742

Table 1: Contextual help.

Task execution:	Successful	Optimal
GEFT test	**p = .01986**	*p = .08782*
BLS4 test	**p = 1.47 E-06**	*p = .09502*

Table 2: Non contextual help. Comparisons between the subjects' performance in both situations – T-test results. Significant results are in bold type, trends in italics.

The statistical results presented in tables 1 and 2 were obtained by grouping together, for each subject, the tasks they performed in each condition (CH and NCH). They indicate that individual exploration capacities, as measured by the GEFT, significantly influenced successful task execution rates (TPS) in either condition, and, to a lesser extent (simple trends), optimal realisation rates (TPO). Higher exploration capacities go together with better results.

Subjects' aptitudes for using help messages effectively (*cf.* the BLS4 test) also exerted a significant influence on successful task execution rates in both situations, but their influence on optimal realisation rates was rather limited in the NCH condition (simple trend), and non-existent in the CH condition (no significance).

We performed further statistical analyses in order to characterize, in each condition, the statistically significant effects of individual cognitive characteristics on performance, namely successful task execution rates.

Results of correlation tests in tables 3 and 4 suggest that:

1. Subjects who got higher GEFT marks completed more tasks successfully in the CH condition, than subjects who got lower marks; and this correlation is significant. On the other hand, there is no correlation in the NCH condition between inter-individual differences in exploration capabilities and successful task execution rates.
2. As for inter-individual differences in general intelligence as measured by the BLS4 test, we observed a significant correlation between BLS4 marks and performance rates (successful task execution) in both conditions, the correlation coefficient being sensibly higher in the NCH condition.

Task execution:	Successful	Optimal
GEFT test	**C=0.545**	*C=0.753*
BLS4 test	**C=0.265**	C=0.109

Table 3: Contextual help.

Task execution:	Successful	Optimal
GEFT test	**C=0.013**	*C=0.248*
BLS4 test	**C=0.377**	*C=0.404*

Table 4: Non contextual help. Correlations between subjects' cognitive profiles and their performance in both conditions. Significant results are in bold type, trends in italics.

The second result may be explained easily, if our assumption that BLS4 marks are correlated with linguistic understanding capabilities is correct. It indicates that subjects had less difficulty in understanding and applying contextual instructions than non contextual help information.

This could be due to the fact that non contextual messages were longer and more complex than contextual ones; hence they were more difficult to interpret, and the useful procedural information they contained was less easy to isolate, assimilate and put into practice.

While these results are encouraging, the rather small difference between the two correlation coefficients may be interpreted as an indication that the information content, wording and presentation of help messages need further improvement in order to facilitate their interpretation, and reduce demands on the general intelligence capacity of novice users.

On the other hand, the first result is somewhat surprising. As contextual help, unlike non contextual help, provides users with some guidance in task execution, it might be expected that subjects would not have to draw upon their exploration capabilities while using contextual help; consequently, significant correlation between GEFT marks and successful task execution rates should not be observed in this condition.

Further empirical and experimental studies are needed in order to confirm this unexpected result and explain it satisfactorily. We observed that, in the contextual help condition, subjects did not always read all the successive messages describing a procedure; they often contented themselves with reading the first one in the sequence. This behaviour may result from what might be considered as a flaw in our experimental protocol: the fact that every help message in the sequence associated with a procedure was displayed automatically as soon as subjects had completed the corresponding step. Therefore, subjects read the first message in such a sequence, started to carry out the instructions included in it, and then got engrossed in carrying on with the

execution of the procedure, so that they often ignored the next message(s). Subjects with lower GEFT scores are more liable to adopt such a behaviour than subjects with higher scores, in-as-much as alternating between two different activities, namely task carrying out and help consulting, implies drawing upon the cognitive capacities measured by the GEFT. Consequently, the high correlation observed between GEFT marks and successful task execution rates in the CH condition may be ascribed to the effects of the strategy we adopted for displaying help messages in this condition, since it induced subjects to adopt behaviours likely to affect both successful task execution and optimal realisation rates.

6 Conclusions and future work

We have described two related studies. The first study is focused on the analysis of empirical data with a view to eliciting the strategies used by human experts to assist novice users in discovering a new application software and attempting to master its operation. The second study is an experiment aimed at assessing the actual effectiveness and usability of a contextual online help system implementing the strategies of the experts. 18 potential users interacted with a text processor on the market, using two help systems successively, a contextual one versus a non contextual one. Each system was simulated, within the framework of the Wizard of Oz experimental paradigm, by 2 human operators whose activity was supported by specific software.

Results stemming from the analysis of task execution times, successful and optimal task executions, indicate that contextual help proved more effective than non contextual help as regards successful task executions, this result being statistically significant. In addition, contextual help proved most effective for the tasks users are less familiar with. However, comparisons between task execution times suggest that contextual help may increase the user cognitive workload with respect to non contextual help.

Further results concern the influence of subjects' individual cognitive characteristics on their performance in each help situation. Results of the GEFT (assessing field dependence) show that low exploratory capabilities limit the effectiveness of contextual help strategies. To remedy this drawback, we are currently considering the implementation and ergonomic evaluation of multimodal messages integrating synthesized speech, and activated on the system own initiative according to the progress of the current task execution mainly.

Results of the BLS4 test meant to evaluate the general intelligence factor suggest that contextual help facilitates message understanding. However, further research is needed in order to further facilitate message understanding and instruction application. We are currently preparing an experimental study with a view to further explore the cognitive processing of help information.

References

Bach, C. (1991). A customizable direct manipulation user interface with automatic generation of help information. In *HCI International 91: Human aspects in computing*, Stuttgart, Lawrence Erlbaum Associates, September 1-6, pp. 920-924.

Berg, M. (1997). What use for social theory in designing technology. In *Society for Social Studies of Science Annual Meeting*, University of Arizona, Tucson, 23-26 Octobre, 1997,

Bonnardel, R. (1970). *B.L.S. 4 - Test d'intelligence générale*. Paris, E.A.P.

Borenstein, N. (1985). *The design and evaluation of online help systems*. PhD Thesis, Carnegie Mellon University; Pittsburg.

Breuker, J. (1990). *EuroHelp: Developing intelligent help systems, Report on the P280 ESPRIT project EUROHELP*. Kopenhagen, Amsterdam, Manchester, Leeds.

Capobianco, A. and Carbonell, N. (2001). Contextual online help: elicitation of human experts' strategies. In *HCI International 2001*, New Orleans, USA, Lawrence Erlbaum Associates, pp. 824-828.

Capobianco, A. and Carbonell, N. (2002). Contextual Online Help: a Contribution to the Implementation of Universal Access. In *First Cambridge Workshop on Universal Access and Assistive Technologies - CWUAAT'2002*, Cambridge, United Kingdom, Springer-Verlag London, pp. 131-140.

Carenini, G. and Moore, J. D. (1993). Generating explanations in context. In *International Workshop on Intelligent User Interfaces*, Orlando, FL, ACM Press, January, pp. 175-182.

Cohill, A. M. and Williges, R. C. (1985). Retrieval of help information for novice users of interactive computer systems. *Journal of The Human Factors and Ergonomics Society,* **vol. 27 (3)**, pp. 335-343.

Coombs, M. J. and Alty, J. M. (1980). Face to face guidance of university computer users: Characterising advisory interactions.

International Journal of Man-Machine Studies, **vol. 12**, pp. 389-405.

DeVries, G. and Johnson, G. I. (1997). Spoken help for a car stereo: an exploratory study. *Behaviour and Information Technology,* **vol. 16 (2)**, pp. 79-87.

Duffy, T. M.; Mehlenbacher, B. and Palmer, J. (1989). The evaluation of online help systems: a conceptual model. In *The society of text: hypertext, hypermedia and the social construction of reality*. E. Barrett (Ed), MIT Press, Cambridge, MA, **vol.,** pp. 362-387.

Dzida, W.; Hoffmann, C. and Valder, W. (1987). Mastering the complexity of dialogue systems by the aid of workcontexts. In *INTERACT'87 (2nd IFIP TC13 International Conference on Human-Computer Interaction)*, Stuttgart, North Holland, pp. 29-33.

Edwards, D. M. and Hardman, L. (1989). "Lost in hyperspace": Cognitive mapping and navigation in a hypertext environement. In *Hypertext: theory into practice*. R. McAleese (Ed), Intellect Limited, Oxford, **vol.,** pp. 105-125.

Goodenough, D. R. (1976). The Role Individual Differences in Field Dependance as a Factor in Learning and Memory. *Psychological Bulletin,* **vol. 83 (4)**, pp. 675-694.

John, B. E. (1990). Extensions of GOMS analyses to expert performance requiring perception of dynamic visual and auditory information. In *CHI'90 Human Factors in Computing Systems*, ACM, pp. 107-115.

Kieras, D. E. (1996). Guide to GOMS model usability evaluation using NGOMSL. In *CHI'94The Handbook of Human-Computer Interaction, 2nd Ed.* M. Helander et T. Landauer (Ed), North Holland, Amsterdam, **vol.,** pp.

Mallen, L. C. (1995). *Designing intelligent help within information processing system*. PhD Thesis, Leeds University; Leeds.

Moriyon, R.; Szelkely, P. and Neches, R. (1994). Automatic generation of help from interface design models. In *CHI'94 (International Conference on Human Factors in Computing Systems)*, Boston, MA, ACM Press & Addison Wesley, pp. 257-263.

Palmiter, S. and Elkerton, J. (1991). An evaluation of animated demonstrations for learning computer-based tasks. In *CHI'91 (International Conference on Human Factors in Computing Systems)*, New Orleans, LA, ACM Press & Addison Wesley, pp. 257-263.

Pejtersen, A. M. and Rasmussen, J. (1997). Ecological Information Systems and Support of Learning: Coupling Work Domain Information to User Characteristics. In *Handbook of Human-Computer Interaction*. M. Helander, T. K. Laundauer et P. Prabhu (Ed), Elsevier Science, **vol.,** pp. 315-346.

Pilkington, R. M. (1992). Question-answering for intelligent on-line help: the process of intelligent responding. *Cognitive Science,* **vol. 16 (4)**, pp. 455-491.

Quast, K.-J. (1993). Plan recognition for context sensitive help. In *IWIUI'93 (International Workshop on Intelligent User Interfaces)*, Orlando, FL, ACM Press, Janvier, pp. 89-96.

Roestler, A. W. and McLellan, S. G. (1995). What help do users need? Taxonomies for on-line help information needs and access methods. In *CHI'95: International Conference on Human Factors in Computing Systems*, Denver, CO, ACM Press & Addison Wesley, pp. 437-441.

Spearman, C. E. (1927). *The Abilities of Man : Their nature and Measurement*. N-Y, Macmilliam Co.

Tattershall, C. (1990). *Question-answering and explanation giving in on-line help systems: A knowledge based approach*. PhD Thesis, University of Leeds, School of Education; Leeds, UK.

Wilenski, R. (1984). Talking to UNIX in English: an overview of an on-line UNIX consultant. *AI Magazine,* **vol. 5**, pp. 29-39.

Witkin, H. A.; Oltman, P. T.; Raskin, E. and Karp, S. A. (1971). *Group Embedded Figures Test Manual*.