INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team Eiffel2

Cognition and Cooperation in Design

Rocquencourt

THEME COG

Table of contents

1. Team

Head of project-team
Françoise Détienne [DR, INRIA-Rocq, HdR]

Vice-head of project-team
Willemien Visser [CR, INRIA-Rocq]

Administrative assistant
Nathalie Gaudechoux [TR, INRIA (shared time with the Complex team)]

Staff member
André Bisseret [DR (Rhône Alpes), (DR emeritus since June 1999)]

Research scientist
Jean-Marie Burkhardt [Assistant professor, Paris 5 - René Descartes University]
Béatrice Cahour [CR, IRIT, since September 2006]

Ph.D. Students
Margarita Anastassova [CEA funded, thesis in Ergonomics at Paris 5 - René Descartes University, defended on December 13]
Flore Barcellini [MESR funded, preparing a thesis in Ergonomics at CNAM]
Thierry Février Quesada [CNAM funded, preparing a thesis in Ergonomics at CNAM]
Laurence Gagnière-Foubert [preparing a thesis in Psychology at Savoie University - University of Geneva]

Graduate Students interns
Lionel Barrand [Paris 8 - Vincennes-Saint-Denis University; CNAM from October 2006 on]
Linda Moutsinga Mpaga [Amiens University ; CNAM from October 2006 on]
Florent Terral [Bordeaux University, April-June 2006]

Graduate Students
Hassane Karkar [Paris 8 - Vincennes-Saint-Denis University]

2. Overall Objectives

2.1. Overall objectives

Keywords: *cognition*, *cognitive ergonomics*, *cognitive psychology*, *collaboration*, *cooperative systems*, *design*, *distributed design*, *evaluation methodology for CSCW*, *technology mediated human-human collaboration*.

The objectives of the EIFFEL team are to model cognitive and collaborative processes involved in complex problem solving activities such as design and to assess and specify tools and methodologies that support them. Our main focus is on human-human collaboration in complex tasks mediated by information and communication technologies, mostly groupware technologies.

Human-human collaboration in complex tasks takes place when three conditions are met: shared resources; a common objective (which can be defined at various levels of granularity and abstraction); and interactions between participants' tasks. For example, in collaborative design, which can be viewed as a paradigmatic case of tightly coupled work, the complexity of the task produces great work interdependencies. Another consequence of this complexity is that solving design problems often requires that multiple competencies be put together, which in turn leads to development of collaboration between co-designers from various disciplines and thus involves the management of multiple perspectives.

The notion of collaboration recovers various processes: coordination processes like planning and task management; grounding, awareness and construction of shared mental models; co-construction, negotiation and other argumentative activities linked to design rationale; action coordination; and also, at the participant level, the notion of interactive profiles. Collaboration is also expressed through multimodal interactions, especially verbal, textual, graphical, and gestural. Our research addresses these various research issues akin to collaboration.

The technologies mediating collaboration, referred to as groupware technology, are classically categorized according to the spatio-temporal set-up in which they are used: for example; virtual and augmented reality in co-presence and synchronous situations; video-conferencing and shared applications in distant and synchronous situations; platforms with discussion lists and CVS (subversion) in distant and asynchronous situations. We rather characterize the technology mediated collaboration situations by the characteristics of these groupware systems and by the characteristics of the communication modes available (e.g., visibility, audibility, simultaneity, as described by Clark and Brennan) as far as these characteristics constrain in some way the activity of the humans using them in their collaborative complex tasks.

Our research topics are organized into three main axes.

- Axis 1: Complex activities and visualization. Under this axis, our target collaborative situation concerns small groups (pairs or small teams) interacting in co-presence or at distance in a synchronous way. The interactions are multimodal and the group interactions are strongly mediated by shared external 2D or 3D representations acting as intermediary or boundary objects in collaboration. Technologies used are scientific visualization and simulation software, and augmented reality. A situation of reference concerns interactions around paper sketches and plans.

  Our current research issues concern: alignment and disalignment in multimodal interactions between architectural designers; multimodal collaborative processes in designing with augmented reality; grounding in distant collaboration around shared visual spaces. A synthesis effort has been made, proposing to analyze design as the construction of representations.
- Axis 2: Distributed design. Under this axis, our target collaborative situation concerns very large groups (hundreds of persons), also called epistemic communities or communities of practice, interacting at distance in an asynchronous way, with a design objective. The interactions are mostly textual, through discussion lists and updates of data repository (e.g. CVS).

  Our current research issues concern mostly the Open-Source Software (OSS) communities: the design process viewed as distributed participatory design; the economical motivations and design choices. Another research issue concerns a cognitive engineering approach to the design of web-based cooperative system.
- Axis 3: Methodological aspects: analysis and evaluation of socio-technical systems. Research on this axis involves the development of two methodological aspects: methodologies for data analysis and for user-centered design and assessment of new technical systems.

  Whereas many research on usage analysis is conducted in the field of CSCW (Computer Supported Cooperative Work), very few are concerned with the evaluation of the socio-technical systems and by the development of generic analysis and evaluation methods, accounting for problem solving efficiency (in terms of product and process) and collaboration quality/efficiency. This is one of our research directions.

  Our current research issues concern: methods for collecting and analyzing data on complex activities, in particular design; methods for the needs analysis of Augmented Reality technologies; methods for the design of Virtual Reality technologies.

3. Scientific Foundations

3.1. Scientific foundations

Keywords: *cognitive ergonomics*, *cognitive psychology*.

3.1.1. Our domain of expertise: Cognitive ergonomics and psychology

The research carried out within the EIFFEL team is grounded in Cognitive Ergonomics and Cognitive Psychology. The main concern of Ergonomics is to accumulate and apply knowledge that is likely to improve efficiency and interest in the work activity, in this case cognitive work, as opposed to purely physiological aspects, which are naturally also important. Traditionally Ergonomics applied to human-computer systems primarily focuses on the interaction between humans and their cognitive work environment (including colleagues, technical devices, their work space). Cognitive Psychology is of major importance in Cognitive Ergonomics, at both a theoretical and a methodological level. In a broader context, Cognitive Ergonomics and Cognitive Psychology belong to the still expanding field of Cognitive Sciences and therefore benefit from the many interactions with the other disciplines that constitute this domain, primarily Computer Science (particularly Artificial Intelligence), Socio-Informatics, Pragmatics and Linguistics.

Our theoretical framework refers to cognition within situations, collective cognition and knowledge development: humans act and learn through interaction with other agents (human or not), in goal-oriented activities and in context. It is based on Newell and Simon's classical cognitive model of information processing, centered on knowledge and reasoning, and on the theory of activity, which has strongly inspired francophone Ergonomics, in particular through its distinction between task and activity. Our approach is also developmental as far as any activity is also an occasion to learn.

Our theorical framework is also constructed in reference to situated action and situated cognition theories, respectively from Schön and Suchman and the distributed cognition theory from Hutchins. On the one hand, we consider that cognition should be understood and situated within a context that is not only technical but also socio-organizational. On the other hand, technologies and humans should be modeled as joint cognitive systems. However, these before mentioned theories and models are not adopted in their extreme position, which under-estimates the planning activity (the human is then considered as only "reacting" to the context modifications) and poorly distinguishes the resources coming from the human from the ones coming from the environment (e. g., technical systems).

3.1.2. A main focus on design

Our focus is on complex tasks. We consider design as a paradigmatic case of tightly coupled work in which the complexity produces great work interdependencies. This is why design has been our main focus.

Design covers a great range of activities in various knowledge domains: engineering design, architectural design, software design, etc. Historically, various research issues have been focused on depending on the particularities of design domains.

In software design and engineering design studies, in which design is guided (if not constrained) by process models and methods, the issues covered are work interdependencies, modular design and coordination issues. In architectural design and other domains like mechanical design in which there are various forms of representation of the design artifact, in particular graphical ones, one important issue has been to understand the roles of these representations in individual and collaborative design. In design of products, where taking into account users or end-users is an important aspect of design, one important issue has been to anticipate the uses by collaborative methods such as participatory design.

As stressed by Thomas and Carroll early in 1979 design activities involved in these various domains have much in common. This is the approach we follow in our research (see for example [23], [47]), assuming that there are similar cognitive and collaborative processes whatever the design application domain. However, some design domains, in which some processes are emphasized, may be heuristically more relevant to study these processes.

3.1.3. Design and HCI

Two relationships between design and HCI may be stressed out. Firstly, the designers can be considered as end users if we consider the technical support through which they perform their design activity. It is the approach we adopt in our research group. We consider the design process going from the initial specifications to the production and maintenance of the design artifact and the tools to support collaboration during this process.

Secondly, we can consider the end-user of the designed artifact. End-users may be more or less involved in the design process depending on the design approach. In classical user-centered design situations, the role of the user is informative (e.g., needs elicitation) and evaluative (e.g., prototype evaluation), whereas in participatory design situations, the role of the user is also generative (solution elaboration) and sometime decisional: this way, the end-user becomes a co-designer. The various ways in which the user may be involved, directly or indirectly, in the design process is also of main interest for our group.

3.1.4. Our methodology: field and laboratory studies

Our methodological approach is to conduct empirical studies, either field studies or laboratory experiments:

- Field studies: our main focus is on work in a natural environment. The favored methodology is observation from within the workplace. We collect "natural" data, such as spontaneous dialogues, written productions, drawings and information constructed, collected and used by individuals in the context of their activity.
- Laboratory experiments: we also conduct "natural" experiments, i.e. experiments in realistic conditions, that is to say with real practitioners, performing realistic tasks, using their common tools in their common environment. We also use knowledge elicitation techniques and post-hoc interviews based on observational data (e.g. videos and transcripts of dialogues).

4. New Results

4.1. Axis 1: Complex activities and visualization

4.1.1. Design as the construction of representations

Participant: Willemien Visser.

Given our focus on design as a paradigmatic case of complex activities, many efforts to model design have been performed in the EIFFEL team through the years. In a synthesis of the research performed since some 30 years in the domain of cognitive design studies, we propose a new perspective on design: design is more appropriately characterized as the construction of representations (internal and external) than as problem solving (which formally it is, of course). This viewpoint constitutes an alternative to today's main theoretical approaches, i.e. the classical cognitive-psychology viewpoint (represented by Simon's symbolic information processing model, with its analysis of design as problem solving) and the situativity standpoint (which, in design studies, generally takes the form of Schön's reflective practice framework). With respect to methodology, breaking with the classical cognitive-psychology approach, where research is mostly conducted in artificially restricted conditions, we claim the necessity to characterize design on the basis of data collected on designers' actual working activity in professional design projects.

We characterize the different representational structures and the activities operating on them; an outline is sketched of directions regarding functional linkages between these structures and activities. We discuss different aspects of the representational structures-e.g., their form and function-and their variations according to the phases of the design process: representations at the source of a design project (requirements or "design problems"), intermediate representations, and representations at the end of a design project (specifications or "design solutions").

The construction of representations is a high-level cognitive activity, which is implemented through three main types of activities, i.e. generation, transformation, and evaluation of representations. These activities resort themselves to other activities and operations, such as interpretation, association, integration, exploration, inference, restructuring, combining, hypothesizing, and also drawing (sketching and other forms) and gesturing (pointing, delimiting, tracing, and other forms).

Our representation-construction framework covers both individual and collaborative design. In addition to the discussion of special data analysis methods, several sections deal however with the specificities of representation in collaborative design: especially, its interactional nature; the construction and use of interdesigner compatible representations, and the specificities of the construction and use of intermediary representations in collaborative design [13], [32].

We defend an augmented cognitively oriented "generic-design hypothesis." There are both significant similarities between the design activities implemented in different situations and crucial differences between these and other cognitive activities; yet, characteristics of a design situation (mainly related to the design process, the designers, and the artifact) introduce specificities in the cognitive activities and structures that are used. Our hypothesis thus combines the generic-design stance with the hypothesis of different forms of designing. We propose some candidates for dimensions underlying differences between such forms of design [47].

4.1.2. Alignment and disalignment in multimodal interactions between architectural designers

Participants: Françoise Détienne, Florent Terral, Willemien Visser.

Designers working together do not necessarily perform sequentially. When their activities occur in parallel (i.e., simultaneously or with more or less overlapping), they may be aligned or disaligned with respect to the object on which they focus through their activity. We have analyzed various forms of alignment and disalignment in interactions between three architectural designers in a collaborative design situation (the MOSAIC meeting). In design meetings of at least three participants, coalitions between two or more designers may take form. We have identified several cases of coalition between two designers in the design meeting analyzed [42].

Disalignment occurs when one or more designers do not focus on the same object as their colleague(s). Having noticed that disalignment often coincides with change of graphical support, we have examined if this behavioral indicator allows identifying the cases of disalignment in a meeting. We have analyzed 20 minutes of the MOSAIC architectural design meeting. The results show that a great proportion of introductions of another graphical support reflect a disalignment (15 out of 19). However, in addition to these 15 cases, 32 other instances of disalignment are not accompanied by such a change.

We observed that the consequences of a disalignment differ. In a few cases, its initiatior gives up immediately and refocuses on the object that was under focus before. In the other cases, two types of consequence can be distinguished: the initiatior of the disalignment is catched up or not. In the former case, the initiatior may be catched up by all or by only a sub-set of the other participants [53].

4.1.3. Multimodal collaborative processes in designing with augmented reality

Participants: Jean-Marie Burkhardt, Françoise Détienne, Linda Moutsinga Mpaga.

Augmented reality (AR) is of main interest in domains where together textual and graphical (2D and 3D) representations are generated and are used as intermediary objects in the collaborative process: this is the case in architectural design. Our research issue is to evaluate how Augmented and Mixed Reality technologies can support the collective dimension of the activity in the context of ill-defined and open tasks like design. In this aim, we have conducted an experiment with pairs of architectural designers working in co-presence with an AR environment, the virtual desktop, developed by the Lucid group at Liege University, which allows freehand sketching and simulations.

Based on methods we developed in previous studies of collaborative design, we have distinguished the design process, collaborative process, as well as the modalities used. The environment together with the co-presence situation offer each modalities of interaction, in which designers maintain easily a shared local context with no problems of co-reference and possibilities of gestural coordination. However, the constraint of sequentiality for entering the data entails an added task of coordination. Other results concern the use of EsQuise, the software that allows sketching and early simulations in design [50], [52]. Our next step is to refine our method to assess the effect of the AR environment constraints and modalities of interaction constraints have both on the design process and on the collaboration process. We will run a second experimental condition with pairs of architects conducting the same task at distance with AR environments.

4.1.4. Grounding in distant collaboration around shared visual spaces

Participants: Lionel Barrand, Françoise Détienne.

Common ground refers to that knowledge people (who interact each other) have in common and they are aware that they have it in common. The establishment of common ground ("grounding") is an important process in design tasks because of the domain and cultural differences of co-designers. This activity ensures inter-comprehension and construction of a shared representation of the current state of the problem, solutions, plans, design rules and more general design knowledge. The establishment of common ground is a collaborative process in which the co-designers mutually establish what they know so that design activities can proceed. Grounding is linked to sharing of information through the representation of the environment and the artifact, the dialog, and the supposed "pre-existing" shared knowledge.

Distant work is mediated by various technologies that may affect grounding. Various media provide distinctive kinds of cues that may imply various kinds and levels of collaborative effort for people to establish common ground [23]. In this direction, we have analyzed grounding in distant collaborative scientific visualization conducted by pairs of scientists and engineers at EDF R & D and EDF SEPTEN. This experiment has allowed us to set up a methodology (inspired by Kraut & Fussell's work) to analyze the collaborative effort and its progression over time through the use of implicit or explicit references to the visual display, combined with an automatic analysis of the domains of semantic references [49]. This work will continue in the framework of the SCOS project (RNTL) starting next year.

4.2. Axis 2: Distributed design

4.2.1. OSS communities: distributed participatory design?

Participants: Flore Barcellini, Jean-Marie Burkhardt, Françoise Détienne.

The design behind OSS (Open-Source Software) (OSSD) becomes an important phenomenon in the computer science world: there are thousands of OSS projects and millions of users of OSS systems. OSS can often involve a distant and asynchronous form of computer-supported collaborative design, and a large number of developers, members of online communities [24], [25], [22]. If there is a lot of research on collaborative design, very few focused on distant and asynchronous design situations. We assume that OSS design process is an interesting paradigmatic case to study distant and asynchronous collaborative work.

Moreover, OSSD is a case of continuous design and can be considered as a case of participatory design. In OSSD, users can be potentially involved in all the phases of the design process. This participation is seen as one of the most important factor explaining the success and the quality of the designed OSS. Thus, OSSD can be considered as a participatory kind of design. Forms of participation in OSS communities are supposed to be "open" in time (the design is continuous) and for different kind of participants whatever they are (administrators, developers, or users). As far as we know, there is no research that aims at understanding globally the OSSD process and the position effectively occupied by users proposing new functionalities in this self-organized design process.

In this direction, the objective of this research is to analyze the ways members of open-source software communities participate in design. In particular, we focus on how users of an Open Source (OS) programming language (Python) participate in adding new functionalities to the language. Our study characterizes the Python galaxy and analyses a formal process to introduce new functionalities to the language called Python Enhancement Proposal (PEP) from the idea of language evolution to the PEP implementation. The analysis of a particular pushed-by-users PEP from one application domain community (financial), shows: that the design process is distributed and specialized between online and physical interactions spaces; and there are some cross participants between users and developers communities which may reveal boundary spanners roles [35], [36]. This on-going research will be extended on the basis of a analysis and methodology developed to study OSS design dynamics focusing on the analysis of quoting practices in online discussions [37], [16], [41] and in collaboration with researchers of the University of California at Santa Cruz with whom we developed a socio-cognitive approach to analyze OSSD [31].

4.2.2. OSS communities: economical motivations and design choices

Participants: Françoise Détienne, Hassane Karkar.

Motivations of software developers to engage in OSS projects have been outlined in recent surveys and studies. Results suggest the following main motivations:

- To gain and improve their knowledge and skills;
- To gain reputation and honor from their peers. This point is also outlined by the OSS movement ideology. Indeed, OSS projects are seen as meritocratic, i.e. technical expertise and individual contribution are seen as the way to socially evolve in the hierarchy within the community;
- To get benefit directly from their work. This point is related to the fact that developers are also users of the artifact they develop;
- To support the OSS movement ideology and beliefs that software has to be free and open source, and that the design process of OSS is better than the proprietary software one.

Finally working in an OSS project provides prestige and visibility that give developers a chance to be noticed by software companies.

In these studies, economical motivations are rarely evoked, even if they seem increasingly present in OSS development in which contributors get benefit from their work in a commercial manner. With a method for mining discussion lists of Python contributors, we have found evidences of economical motivations that influence design decisions in a manner that is consistent with the economical theory of network [51].

4.2.3. A cognitive engineering approach to the design of web-based cooperative system

Participant: Thierry Février-Quesada.

In collaboration with Françoise Darses, CNAM.

Following the results of the MAGIE project, we continued related research issues in 2006. On the one hand, the cognitive modeling of collective-design tasks allowed the design of a cooperative environment [45], on the other hand a doctoral dissertation (planned for spring 2007) is going to explore the synchronous and asynchronous ways of cooperative practices of an innovation project team. In particular, the prescribed tasks will be compared with the undertaken activities. The various types of exchange and dialogue will be also analyzed. Lastly, based on the analysis of verbal data dialogues, we will deal with descriptors of cognitive and operational synchronizations. Thus, The Cognitive Task Analysis (CTA) will allow guidelines to design web-based platform for a larger collaborative work process.

4.3. Axis 3: Methodological aspects: analysis and evaluation of socio-technical systems

4.3.1. Methods for collecting and analyzing data on complex activities, in particular design

Participants: Béatrice Cahour, Françoise Détienne, Willemien Visser.

Cognitive psychologists and ergonomists have proposed various methods for the analysis of individual verbal protocols, but much less for dialogues in collective work settings. Many professional activities, however, are carried out by people working together through verbal interaction. From a perspective of cognitive ergonomics, we have developed principles for the analysis of collaborative design, amongst which the COMET method. An extension of COMET has been elaborated for the analysis of distant and mediated collaboration.

Dialogue analysis has long been the concern of linguistics, especially pragmatic linguistics. In task-oriented design activities, dialogues are said to be cooperative since the partners share a common goal: they have to converge towards agreement concerning a solution. That is why they differ from several other types of dialogues, such as political debates, interviews, chatting, where the aim is not primarily to collaborate towards a common outcome.

In the framework of the MOSAIC project, we have compared analysis methods adopted and results obtained by researchers from cognitive ergonomics and linguistics, the two disciplines collaborating in this project. Various approaches to analysis have been elaborated, compared and discussed in the framework of a book, in press, co-edited by F. Détienne and V. Traverso [27], [28], [29], [21], [26], [15], [11], [33].

One direction followed has been to develop and test an analytical framework [15] that aims to bring out the nature of participants' contributions to co-design meetings, in a way that synthesizes content (epistemic) and function (argumentative) dimensions, together with the dimension of dialogicality (referred to as "enonciative"). We term the resulting global vision of contribution, the "interactive profile". An interactive profile is made up of the emerging roles adopted by a participant on several dimensions. This work is being extended to analyze the quality of the collaboration in teamwork.

Another direction has been to confront cognitive ergonomics' and linguistics' methodological approaches to the analysis of the MOSAIC corpus through a twofold analysis of a same segment of this corpus. The results of this confrontation concern two levels: the data-analysis method (the object or objects of analysis and the levels of structuring the corpus) and the interpretations adopted by each discipline (status attributed to a pre-existing theoretical framework). Interestingly, the methodological questions have been not only of a comparative nature: they have influenced each individual analysis. The cognitive ergonomics' analysis has been extended in two directions compared to previous analyses: consider the multi-modality of the interaction and proceed to a finer coding of the design solutions [33].

Besides, a review of methods for collecting and analyzing data on complex activities has been written. Starting with methods developed for design, we examine possibilities for their transposition to other complex activities (especially, referring to sensorial experience) [48].

4.3.2. Methods for the design of Augmented Reality technologies and Virtual Reality technologies

Participants: Margarita Anastassova, Jean-Marie Burkhardt.

A doctoral research has been conducted on methods for the needs analysis of augmented realities technologies. This research is carried out within the framework of (1) an industrial co-operation between the French Atomic Energy Commission (CEA) and Renault S.A.S and (2) the APLG project funded by the RIAM program and (3) the Virthualis Project [38], [44] devoted to the merge of VR technology with Human factors knowledge and methods for safety. An evaluation of various methods used in the field of ergonomics for design has been carried out in terms of relevance and help provided for the needs analysis step (semi-directed interviews, observation-based task analysis in real training sessions and user-tests of an AR prototype [34]. From a methodological perspective, we conclude that all these methods help the elicitation of clear and conscious user needs. In conclusion, we propose several directions for the analysis of unconscious user requirements, which usually characterize users' position in early design of emerging technologies [14].

Furthermore, a synthesis of the literature on relevant methodological aspects for the design of new emerging technologies, especially for VR and AR has been carried out [17], [19], [12], [30], [18]. In parallel, empirical studies for VR usability were carried out in various contexts [46], [39], [40], [20], in particular to establish design principles for the manipulation of virtual objects in 3D. A review of current trends and relevant issues to be developed in cognitive ergonomics for VR is in progress.

5. Contracts and Grants with Industry

5.1. Contracts and Grants with Industry

5.1.1. Research contract FTR&D (Activités collaboratives assistée par la réalité virtuelle et augmentée : questions de recherche en ergonomie informatique).

Participants: Jean-Marie Burkhardt, Françoise Détienne, Linda Moutsinga Mpaga.

This research, which has began in September 2005, aims to evaluate how Augmented and Mixed Reality technologies can support the collective dimension of the activity in the context of ill-defined and open tasks like design. We will investigate (a) the requirements and functions needed in situation of collaboration, (b) the limits and contributions of current technologies in terms of utility (functionalities) and usability (interface and interaction) in collaborative activities of design in order to propose (3) a method to evaluate the support and potential negative effect of AR/MR systems on the collaborative design activities.

5.1.2. Grant for PhD Student on methods for the design of emerging technologies funded by the French Atomic Energy Commission (CEA) and Renault S.A.S.

Participant: Margarita Anastassova.

The goal of this PhD work was to compare the advantages and the disadvantages of different methods used for user-needs analysis in early design of an emerging technology, namely Augmented Reality (AR). This technology should be applied to the training of automotive maintenance technicians. After a literature review on the ergonomics issues of AR for maintenance and training, we realized four studies using three methods for user-needs analysis (semi-directed interviews, observation-based task analysis in real training sessions and user-tests of an AR prototype). The results of our studies show that nowadays technicians' and trainers' activity is mainly centered on fault diagnosis. From a methodological perspective, we conclude that all these methods help the elicitation of clear and conscious user needs. In conclusion, we propose several directions for the analysis of unconscious user requirements, which usually characterize users' position in early design of emerging technologies.

5.1.3. Grant for PhD Student on methods for the design of emerging technologies funded by the French Atomic Energy Commission (CEA) and Renault S.A.S.

Participants: Lionel Barrand, Françoise Détienne.

An internship at EDF has been the occasion of the analysis of distant collaboration around a shared visual workspace for scientific visualization.

6. Other Grants and Activities

6.1. International collaboration

- **UC Berkeley-Santa Cruz project**:
  Participants: Flore Barcellini, Jean-Marie Burkhardt, Françoise Détienne.

  Collaboration with UC Berkeley and UC Santa Cruz on "Social and Cognitive Analyses of Collaborative Design for Open Source Software", funded by the France Berkeley Fund, is currently in progress with Warren Sack (UC Berkeley, UC Santa Cruz).
- **USP-NOMADS**:
  Participants: Françoise Détienne, Willemien Visser.

  Collaboration with USP Universidade de São Paulo, Escola de Engenharia de São Carlos, Dep. de Arquitectura e Urbanismo, NOMADS on "Assistance to distant collaborative design using software tools".

6.2. European Collaboration

- **Université de Genève**:
  Participants: Françoise Détienne, Laurence Gagnière-Foubert.

  Collaboration on "Metacognition in distant collaborative learning" is currently in progress with Mireille Bétrancourt (TECFA, University of Genève).

- **Université de Liège**:
  Participants: Jean-Marie Burkhardt, Françoise Détienne, Linda Moutsinga Mpaga.

  Collaboration with the Lucid Group on Augmented reality in collaborative design has started this year. This group has developed a design virtual desktop (le bureau virtuel), which is tested for collaborative design task.

6.3. National Collaboration

- **Project SCOS (Systèmes Complexes Open Source) - RNTL program Labellisé pôle de compétitivité System@tic**:
  Participants: Lionel Barrand, Françoise Détienne.

  Collaboration with Artenum (SS2L), Bull, CEA, CNRS/CCSD/Ciel, Ecole Centrale de Paris/MAS, ONERA/DESP, CS, Safran, EDF, ENS Cachan/CLMA, Grooviz, IFP, GET-INT, LIRIS, Mandriva, Oxalya, INRIA/SCILAB, SETI, TER@TEC, Dassault Aviation and ESA/TEC.

  The project aims to specify and develop an open-source generic platform for the development of complex systems. Our involvement will concern the specification and evaluation of collaborative environment for distant scientific visualisation.
- **Project APLG (Atelier Pédagogique Logiciel Générique) - RIAM program**:
  Participant: Jean-Marie Burkhardt.

  Collaboration with AFPA, Ecole des Mines de Paris, Laboratoire d'Informatique de l'Université du Maine, SNCF, Clarté, Communication & Système. This project aims to specify a generic pedagogical computer-assisted software environment for the development of learning-oriented Virtual Environments. In the first phase of the project, we have analyzed user needs in the context of existing virtual environment for training and we have participated in the development of a task-based model to monitor learner behaviours in simulated virtual worlds. In this final phase, we are carrying out an experiment with the resulting prototype.
- **Projet PERF RV2 (Plateforme d'Etude et Recherche Française de Réalité Virtuelle) RNTL-ANVAR - Labellisé pôle de compétitivité System@tic**:
  Participant: Jean-Marie Burkhardt.

  In collaboration with Stanislas Couix, U. Paris 5.

  Collaboration with IRISA-Siames, UTC-Heudiasyc, Ecole des Mines de Paris, AFPA and Nexter. The RNTL PERF-RV Platform proved virtual reality to help industries in reducing the time and cost for the development of the new products. PERF RV2 aims to demonstrate that integrating virtual humans in the digital factory can improve the design process in terms of effectiveness and the ergonomics of the working stations. In particular, our task is to provide task analysis formalism and models to support the implementation of ecological behaviours in virtual simulation of work [43].
- **Projet Corsaire (COmbinaison de Rendus Sensorimoteurs pour l'Analyse Immersive de RESultats) (ARA Masse de Données program of the ANVAR)**:
  Participant: Jean-Marie Burkhardt.

  In collaboration with Julien Nelson, U. Paris 5.

  Collaboration with Université Paris 6-11 LIMSI, Université Paris 7 EBGM, IRCAM and Haption. The CORSAIRE project aims to assist the activity of data exploration in two application fields: bioinformatics (molecules docking) and mechanics of fluids (exploration of computer simulations of fluids). The specificity of the project is the integration of two technical innovations: immersive interaction with the data in a large-display based Virtual Environment, and the combined use of the visual, auditory and haptic modalities to display the data and to support the interaction.
- **MultiFiches (self financing)**:
  Participant: André Bisseret.

MultiFiches is an on-line bulletin, published monthly on the Internet and devoted to the domain of multimedia documents and interface design. About forty journals are regularly examined. Each issue presents short papers likely to be of interest to practitioners. The writers are: André Bisseret (DR emeritus INRIA), Mireille Bétrancourt (Professor at Geneva University), Anne Pellegrin (Head of the ergonomists' team at Clips-Multicom) and Nathalie Lépy (Consultant in cognitive sciences; this year, she was a member of the VASY project at INRIA Rhône Alpes). From 2002 to the end of 2006, more than 300 short papers were published; in 2006, seventy more papers have been added. A textual base has been released which contained nearly 400 articles, at the end of 2006.

- **Clips-Multicom - CNRS-Grenoble University**:
  Participant: André Bisseret.

  Clips is a research centre in Grenoble specialized in language communication and person-computer interfaces. Part of Clips, Multicom is a laboratory devoted to the evaluation of interfaces (Director: Jean Caelen). André Bisseret is collaborating with Clips and Multicom as scientific adviser in cognitive psychology and ergonomics. MultiFiches is published on the Clips' site (http://www-clips.imag.fr/multicom/web_site_multicom/Multifiches/)

7. Dissemination

7.1. Roles in the scientific community

7.1.1. Organizing scientific events

- "Methodological principles for analyzing and assessing collaborative design", Symposium at IEA 2006, the 16th congress of the International Ergonomics Association. 10-14 July, Maastricht, the Netherlands: F. Détienne and W. Visser, Co-organizers

7.1.2. Journals' editorial boards

- Interacting with Computers: F. Détienne (member of the editorial board).
- International Journal of Design Sciences & Technology: W. Visser (member of the International Advisory Board).
- AI EDAM, Artificial Intelligence for Engineering Design, Analysis and Manufacturing: F. Détienne, W. Visser (reviewing).
- Design Studies: F. Détienne (reviewing).
- Le Travail Humain: B. Cahour, W. Visser (reviewing).
- Psychologie Française: W. Visser (reviewing).
- @ctivités: B. Cahour (reviewing).
- Intellectica: B. Cahour (reviewing).

7.1.3. Conference Program committees

- ACM DIS 2006, Designing Interactive Systems, State College, PA (US), June 26-28, 2006: F. Détienne.
- COOP 2006, Carry-le-Rouet, France, May 9-12: F. Détienne, B. Cahour.
- CITE 2006, Nantes, June 26-28, 2006: F. Détienne, B. Cahour.
- ECCE'2006, Zürich, sept 20-22, 2006: F. Détienne.
- EPIQUE'2007, Nantes, Sept 11-13 2007: B. Cahour, F. Détienne, W. Visser.

- SCAN'07, 2èmes journées du Séminaire de Conception Architecturale Numérique, "Apports de l'image numérique à la conception", Liège, Belgium, 2007, May 10-11: F. Détienne, W. Visser.

7.1.4. Other expert activities

- ANR RNRT: F. Détienne, reviewer.
- ANR Programme blanc: J.-M. Burkhardt, Reviewer.
- NOE Intuition 6ePCRD: J.-M. Burkhardt, Member.
- FNR (Luxembourg) Programme Vivre: J.-M. Burkhardt, Reviewer.

7.1.5. Professional and academic societies

- EACE (European Association of Cognitive Ergonomics): F. Détienne, W. Visser.
- PPIG: J.-M. Burkhardt, F. Barcellini, F. Détienne.
- CE2 (Collège des Enseignants Chercheurs en ergonomie): J.-M. Burkhardt.
- AFRV (Association Française de Réalité Virtuelle): J.-M. Burkhardt.
- SELF: J.-M. Burkhardt.
- ARCo (Association pour la Recherche Cognitive): W. Visser.
- GRAPE (Groupe de recherche en Psychologie Ergonomique): F. Détienne, B. Cahour.

7.2. University teaching

- Université de Technologie de Troyes, "Information and Telecommunication Systems Engineering" Master. F. Barcellini: "Usages, services and Terminals: methods and tools for an ergonomic design" (3h).
- Université de Technologie de Troyes, "Knowledge and Communities Management" Master. F. Barcellini: "Ergonomics and Human - Systems Interactions" (3h).
- Université Paris 5, "Mathematics and Computer Science for Biology" Master. F. Barcellini: "Ergonomics and Human - Systems Interactions" (15h).
- Université Paris 5, Psychology Department: J.-M. Burkhardt, senior lecturer.
- Université Paris 5, Psychology Department: M. Anastassova, TD, Introductory Statistics for 1st year undergraduate psychology students (24h/year).
- Université Paris 5, Psychology Department: M. Anastassova, lecture in Introduction in Ergonomics for 1st year psychology students (3h/year).
- University Paris 5, UFR Biomédicale: M. Anastassova, lecture in Ergonomics of Augmented Reality, MA in Ergonomics (3h/year).
- F. Détienne is research director for DEA students in Ergonomics (CNAM - Paris V-Paris VIII). The Eiffel group receives students from these departments.
- Master Recherche Ergonomie CNAM: F. Détienne "Méthode d'analyse de corpus" (3h).
- Master Recherche "Processus Cognitifs" U. Paris 8: F. Détienne "Conception et collaboration" (4h).

7.3. Invited talks and Scientific popularization

- **M. Anastassova**
  - Séminaire ERASMUS Université Paris 5 / Université de Porto / CNAM, June 28, Université Paris V: "Conception d'un dispositif de Réalité Augmentée d'aide à la formation en maintenance automobile".

- **J.-M. Burkhardt**
  - 4ième Ecole thématique CNRS EIAH "Simulation, réalité virtuelle et augmentée pour l'apprentissage", La Grande Motte, July 3: "Ergonomie de l'interaction dans les environnements virtuels d'apprentissage".
  - 4ième Ecole thématique CNRS EIAH "Simulation, réalité virtuelle et augmentée pour l'apprentissage", La Grande Motte, July 2. "Simulation, réalité virtuelle et augmentée pour l'apprentissage : un panorama" (with M. Joab).
  - Séminaire doctoral "Formation et développement des compétences professionnelles", Chaire de communication Didactique CNAM, Paris, May 10: "Réalité virtuelle, formation et ergonomie".
  - Séminaire du département Communication Homme-Machine, LIMSI CNRS, Université de Paris Sud, Orsay, Januar 17: "Ergonomie des Environnements Virtuels pour la Conception et pour la Formation : Aspects Cognitifs".
  - Séminaire ERASMUS Université Paris 5 / Université de Porto / CNAM, 28 Juin 2006, Université Paris V: "Prise en compte de la dimension apprentissage en Ergonomie des NTIC".
- **F. Détienne**
  - CSI Communications (Computer Society of India): Edition of a special issue on "Psychology of programming: understanding practices and team work", August 2006.
  - PPIG Newsletter (Psychology of Programming Interest Group): Edition of a special issue on "understanding practices and team work", September 2006.
  - Séminaire de recherche de l'unité de recherche IKU (Interaction Knowledge Usage) de l'Université de Liège, Januar 27, Liège, Belgium. "Approche ergonomique de la conception collective" (with W. Visser).
- **W. Visser**
  - 4ième Journée d'étude organisée par Le Sensolier, "Les expertises sensorielles : Nature et acquisition", 12 octobre, Ivry-sur-Seine (CNRS): W. Visser, Invited conference: "Les connaissances expertes du point de vue de l'ergonomie cognitive".
  - Pontifícia Universidade Católica de São Paulo, Prog. de Estudos Pós-Graduados em Língua Portuguesa, Comunicação e Semiótica, April 11: "Analyze de dialogues et conception en architecture".
  - Universidade de São Paulo, Escola de Engenharia de São Carlos, Dep. de Arquitectura e Urbanismo, Prog. de Pós-Graduação, April 18: "Collaborative architectural design: The cognitive-ergonomics viewpoint".
  - Universidade Federal do Rio de Janeiro, Fac. de Letras, Prog. de Pós-Graduação em Letras Neolatinas, April 24: "Analyze de dialogues et activité de conception en architecture".

7.4. Participation in scientific events

- Europython 2006. July 3-6. Geneva, Switzerland. Communication: Flore Barcellini.
- PPIG'06, 18th workshop on Psychology of Programming. September 7-8 . Brighton, UK. Communication: F. Barcellini, F. Détienne, J.-M. Burkhardt.
- Summer School Research Group Information and Communication Technology and Society (GDR TIC et Société). September 11-15. Autrans, France. Participation: F. Barcellini.
- CSCW 2006, Computer Supported Collaborative Work Conference. November 4-8. Banff, Alberta, Canada. Participation: F. Barcellini, F. Détienne. Workshop on Suporting the social side of large-scale software development. Communication: F. Barcellini, F. Détienne.

- COOP'06, 7th International Conference on the Design of Cooperative Systems, May 9-12, Carry le Rouet. Communication: W. Visser.
- IEA 2006, the 16th congress of the International Ergonomics Association, July 10-14, Maastricht, the Netherlands. Communication: F. Détienne, F. Barcellini, W. Visser.
- Wonderground, the 2006 DRS (Design Research Society) International Conference, November 1-4, Lisbon, Portugal. Communication: W. Visser.
- Ergo'IA 2006, October 11-13, Biarritz, France. Communication: M. Anastassova, J.M. Burkhardt
- Journées CNAM "Simulation et apprentissage", December 2005, CNAM. Participation: Anastassova.

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[13] W. VISSER. *The cognitive artifacts of designing*, Mahwah, NJ: Lawrence Erlbaum Associates, 2006.

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