	Trends Research ENabler for Design Specifications
	FP6-IST-2005-27916
Deliverable	**D 2.6 User test protocol**
Security Classification :	**PU**
Leading partner	**LCPI SERAM**
Issue Date	**31/10/06**
Version	**1**
Authors	**Steve Westerman, Stéphanie Buisine, Carole Bouchard, Sukhvinder Kaur, Céline Mougenot**
Approved by	**Améziane AOUSSAT**
Date	**04/12/2006**

User tests protocol
Workpackage 2 - Task 2.3

This document presents the evaluation goals of the TRENDS project and defines several protocols for iterative user tests.

Acronym	TRENDS
List of participants	LCPI SERAM PERTIMM INRIA ROBOTIKER CRF (FIAT) STILE BERTONE UNIVERSITY OF LEEDS UNIVERSITY OF CARDIFF
Coordinator organization	LCPI SERAM : Laboratoire Conception de Produits et Innovation, SOCIETE D'ETUDES ET DE RECHERCHES DE L 'ECOLE NATIONALE SUPERIEURE D'ARTS ET METIERS
E-mail contact person	carole.bouchard@paris.ensam.fr
Project Website	www.trendsproject.org
Project Type	STREP (Specific Targeted Research Project)
Contract number	FP6-IST-27916
Start Date	1 January 2006
Duration	36 months

0. INDEX

1. INTRODUCTION 3
1.1 WORK PACKAGE 2 OBJECTIVES: DESIGN OF THE SYSTEM ARCHITECTURE 3
1.2 DESCRIPTION OF WORK TASK T2.3 3
1.3 AUDIENCE AND SCOPE OF D2.6 3
1.4 STRUCTURE OF THE REPORT 4
2. BACKGROUND 5
2.1 CONTENT-BASED IMAGE RETRIEVAL (CBIR) 5
2.1.1 Developing CBIR techniques based on affective content of images 6
2.1.2 The benefits of focus versus diversity in search results to support creative task performance 6
2.2 CONJOINT TRENDS ANALYSIS (CTA) 6
2.2.1 The implications of attribute characteristics 7
2.3 A USER-CENTRED/PARTICIPATORY DESIGN PROCESS 7
2.4 AN ITERATIVE DESIGN PROCESS 8
3. USER TESTING: METHODOLOGY 11
3.1 METHODS OF DATA COLLECTION 11
3.1.1 Semi-structured interviews 11
3.1.2 Storyboarding 12
3.1.4 Verbal protocols 12
3.1.5 Gathering user performance data 13
3.2 PROTOCOLS FOR DATA GATHERING 13
3.2.1 Data handling procedures 14
3.2.2 Language 14
3.2.3 Data formats 14
3.2.4 Transfer of data between sites 15
3.2.5 Ethics 15
3.3 PERSONNEL RESOURCES 15
4. SCHEDULE FOR TESTING 16
4.1 ITERATION 1: GRAPHIC INTERFACE 17
4.1.1 Objectives 17
4.1.2 Tasks and methodology 17
4.1.3 Timescale 18
4.1.4 Risks to be resolved 19
4.2 ITERATION 2: COMPONENT PROTOTYPE 19
4.2.1 Objectives 19
4.2.2 Tasks and methodology 19
4.2.3 Timescale 20
4.2.4 Risks to be resolved 20
4.3 ITERATION 3: FULL PROTOTYPE 20
4.3.1 Objectives 20
4.3.2 Tasks and methodology 20
4.3.3 Timescale 20
4.3.4 Risks to be resolved 20
4.4 ITERATION 4: OPERATIONAL PROTOTYPE 21
4.4.1 Objectives 21
4.4.2 Tasks and methodology 21
4.4.3 Timescale 22
4.4.4 Risks to be resolved 22
5. CONCLUSION 23
6. REFERENCES 24
7. LIST OF FIGURES AND TABLES 26
8. GLOSSARY 27

1. INTRODUCTION

This document presents the deliverable D2.6, 'User Test Protocol', which belongs to WP2, Design of the System Architecture and more specifically to task T2.3, 'Definition of a procedure for the mono-sector mappings, ambiences and pallets definition and statistics module and user test protocols'. The aim is to define a general framework for the evaluation studies which will be conducted as part of the TRENDS project. These evaluations form an iterative testing process including intermediate tests in WP2 (which will focus on system architecture), WP3 (semantic search engine), WP4 (automatic image analyzer), WP5 (web agent) and WP6 (user interface) as well as final evaluations in WP7 "End-user evaluation".

1.1 WORK PACKAGE 2 OBJECTIVES: DESIGN OF THE SYSTEM ARCHITECTURE

The objective of WP2 is to develop design specifications for the overall architecture of the system. The results of WP1 will form a basis and the approach will be informed by the Conjoint Trends Analysis (CTA) methodology (see below for description). The resulting system should be adaptable to designers in all industry design sectors (e.g., automotive, furniture, cosmetic, textiles).

The detailed list of objectives is as follows:

- To specify an initial sociological and design trends database.
- To define a procedure for the identification of the sectors of influence and the websites for the extraction of sociological and design trends.
- To define a procedure for the realisation of mono-sector mappings, and ambience, pallets and statistics components (see below for details).
- To define graphical interface design specifications.
- To design the software architecture of the TRENDS system software for presenting sociological and styling trends.
- To validate the software architecture with end users.
- To define the user test protocols.
- To define the choice of the communications protocols and data transfer functions
- To define elements that will be used: computer, processors, programming language,

1.2 DESCRIPTION OF WORK TASK T2.3

Task T2.3 corresponds to the '*Definition of a procedure for the mono-sector mappings, ambiences and pallets definition and statistics module and user test protocols'*. It is closely linked to task T2.4, *'Graphic Interface'* and task T2.5, *'System Infrastructure'*, which are concerned with the development of the interface and system architecture elements of the TRENDS system.

1.3 AUDIENCE AND SCOPE OF D2.6

This deliverable D2.6 '*User Test Protocol'* is intended for use by all members of the TRENDS project team. It is also intended for submission to the EC. It addresses the contribution of user testing to the TRENDS project. It describes testing methods that will be employed, and sets out plans in the context of system development. It provides a guide for development and user testing activities.

1.4 STRUCTURE OF THE REPORT

In the next section of this document we briefly describe the TRENDS project, we elaborate on two of the key research themes (Computer-based image retrieval and Conjoint Trends Analysis), and we explain why a programme of user testing is an integral project component and how this will be achieved. To this end, Section 3 contains a description of user testing methodologies that will be employed and procedures relating to data processing/handling are set out. Finally, in Section 4, a timetable for system development and associated user testing is provided.

2. BACKGROUND

The overall goal of the TRENDS project is to develop "interactive software for the elaboration of design trend boards dedicated to product designers, in B to C markets, such as the automotive and original equipment manufacturers" (Annex I). As a routine part of the creative process product designers search for and collect materials that they find inspirational. Although these materials take many forms, including samples of fabric and textual information, images predominate. The TRENDS computer-based system will improve designers' access to web-based resources, helping them to find appropriate material, to structure this material in ways that support their design activities (e.g., presentations to colleagues and to clients), and identify design trends in this material. This will be achieved through the development of flexible content-based image retrieval facilities that utilise ontological referencing, an appropriate user interface, and a software realisation of procedures relating to Conjoint Trends Analysis (Bouchard et al., 1998). It is important that the developed system is maximally compatible with the characteristics and preferences of the intended users, the tasks that they perform, and the contexts in which they perform those tasks. For this reason a user-centred/participatory design process has been adopted.

2.1 CONTENT-BASED IMAGE RETRIEVAL (CBIR)

With so much information available on the web the difficulty lies in providing appropriate methods of interaction so that users can locate relevant material (Pirolli, 2003). This is particularly true when dealing with images where the main difficulty arises from their multi-dimensional and subjective nature. In the context of industrial design these issues may be exaggerated due to the influence of inter-individual context- or domain-related subjectivity. When databases are very large (the TRENDS image database contains about 500 000 images) the problems are compounded.

CBIR Systems are software solutions that can be applied in the context of such large databases. The technologies used come from a range of scientific knowledge bases, including statistics, pattern recognition, signal processing, and computer vision. Systems have been developed to support the instigation of image search via a number of different types of user queries. These include:

- Q*uery by example* - the user initiates a search with a query image. The software finds similar images on the basis of low-level criteria.
- *Query by region of interest* - the user selects a region of an image as the basis of a search. The software finds similar images as in the previous case
- *Query by concept* - users enter a query in the form of key words. Due to the richness of language and the complexity of searched concepts, this may not be sufficiently accurate (often referred to as the 'semantic gap' between retrieved images and intended concept). One approach to close the 'semantic gap' is to develop a CBIR system that automatically generates additional search terms on the basis of conceptual similarity with the original terms (as identified through term co-occurrence in a corpus or through the use of ontologies). In this way the original search can be refined.
- *Query by relevance feedback* - this approach allows the user to filter progressively a search by scoring resulting images as *relevant* or not. The search is then repeated using this information as the basis for image retrieval.
- Q*uery by sketch* - the user draws a rough sketch of the image they are looking for and the software locates images that match the sketch. This is similar in principle to 'query by example'.

As emphasized in D1.2, '*List of usage issues with current design systems'*, designers use many sources of influence and are therefore likely to benefit from assistance in accessing, managing and categorizing visual information. Although CBIR is a very prolific research area involving various available technologies, there are few CBIR systems dedicated to industrial designers. Indeed designers mainly deal with visual information that they link with particular feelings. And yet the core of recent image retrieving tools is mainly based on visual content processing more related to low level features.

2.1.1 Developing CBIR techniques based on affective content of images

The affective properties of images are a potential source of inspiration for designers. However, the automatic identification of such abstract image properties, on the basis of query by concept, is very difficult (Wang & Wang, 2005). Naphade *et al.* (2002) suggest that matching semantics with physical characteristics might be achieved by employing both top-down and bottom-up techniques. They proposes a relevance feedback based interactive retrieval approach, which effectively takes into account the above two characteristics in CBIR. During the retrieval process, the user's high-level query and perception subjectivity are captured by dynamically updated weights based on the user's feedback. The experimental results over more than 70000 images show that the proposed approach greatly reduces the user's effort of composing a query, and captures the user's information need more precisely.

The focus in Kansei Enginering methods is on the viewer rather than on the image (Black *et al.*, 2004). Similarity measures derived from Kansei indexing represent similarities in inner experience, rather than visual similarity. In this way, in order to adapt the information search systems to design activity including a high percentage of image information, new approaches must be developed, integrating the highest levels of information in their processes, and better asimilating the meta-information for searching.

2.1.2 The benefits of focus versus diversity in search results to support creative task performance

Techniques for assessing the quality of information retrieval are well established (see e.g., Baeza-Yates & Ribeiro-Neto, 1999). However, there is little understanding of the requirements for information retrieval in the context of a creative process such as industrial design. For creative tasks it is possible that, instead of highly focused searches being optimal, some diversity in retrieved material is useful (Bonnardel & Marmèche, 2005). This idea is supported by the results of Ansburg & Hill (2003) who found that creative thinkers tend to use more peripheral cues (data not directly linked to the problem) (see also Hocevar,1980). Of relevance is the theory of 'Conceptual Blending' (Fauconnier and Turner, 1998). This holds that the process of thought involves 'moving' between mental spaces that organise our knowledge of the world. Creativity can be conceived as the combination (or conceptual blending) of two, or more, conceptual spaces. This process requires both divergent and convergent thinking (Periera & Cardoso, 2002). The benefits of information diversity, as a facilitator of creativity (in contrast to *traditional* focused information retrieval) are something that will be explored further in the TRENDS project.

2.2 CONJOINT TRENDS ANALYSIS (CTA)

The earliest phases of cognitive design activity were studied in order to define the Conjoint Trends Analysis (CTA) method. The method has been detailed in TRENDS D2.2 and D2.3. CTA makes it possible to enrich and to inspire the designers when designing a new product. It takes place in the early phases of the design process using the steps shown in Figure 1.

Figure 1: The Conjoint Trends Analysis method

CTA enables the identification of attributes linked to particular datasets (e.g., common properties of images in a database) so that they can be used to inspire the early design of new products. More precisely, CTA results in the production of trend boards that can represent sociological, chromatic, textural, formal, ergonomic and technological trends. The Trend boards communicate identified homogeneity in terms of style and consumers' sociological values. They are based mainly on visual information, and result from the frequent occurrence of certain properties within a dataset. From this analysis, images and relevant words are selected and formalized under the form of *ambiences*. Global and discrete design elements are then extracted from these ambiences under the form of *pallets*. These design elements are used for the generation of new design solutions.

The trend board offers a relatively exhaustive representation of the references usually used by the designers for their composition and plays an important role in stimulating idea generation while anchoring contextual matter. It reinforces the link and semiotic coherence between the consumers end values, functionalities in any domains of influence, and product attributes as form, colour, texture, and usability principles. Another purpose of the trends analysis is to define user-convenient principles and solutions that can be integrated in future products. Indeed designers often have to provide new designs using insufficient information about consumers. Trend boards show ambiences including people in context. Contexts are decisive in the attribution of a signification to the object.

2.2.1 The implications of attribute characteristics

There are various ways in which characteristics of images and designs can be described. A potentially important distinction can be drawn between abstract (e.g., mood) and concrete (e.g., shape) attributes (see e.g., Johnson, 1989; Snelders & Schoormans, 2004). The notion of being able to think about designs at different levels of abstraction is well established (e.g., Rasmussen, 1986). Such variation in attribute type may have implications for the process of image search. The relatively greater conceptual complexity of abstract attributes may lead to greater 'semantic gap' (see Section 2.1). However, it seems that a more complex taxonomy of attributes needs to be applied to describe the situation for concrete attributes. Although some concrete attributes (e.g., colour) are amenable to detection within images on the basis of low-level matching, others (e.g., related to semantic category membership - such as 'car') are much more problematic. The key factor here seems to be the complexity of mapping between visual representation and the attribute in question (one-to one versus one-to-many).

Related to this are considerations of the ways in which different attribute characteristics influence the manner in which they can be used in the design process. Ambiguity of meaning may be important, providing abstract attributes with a 'flexibility' that is not afforded by concrete attributes. The argument here, again, can be conceived along the lines of one-to-one versus one-to many mappings.

It is important for designers to be able to 'import' characteristics from one design domain into another. The extent to which attributes generalise across different designs varies, but this does not relate simply to level of abstraction. Attributes that are both 'high' (e.g., 'aggressive') and low (e.g., 'red') in abstraction can apply to different design domains (e.g., transferring from 'cars' to 'food packaging'). Assessing the degree of domain specificity of attributes may be an important variable for consideration, and is also a variable that is central to the CTA process.

These issues relating to attribute characteristics have implications for the manner in which the TRENDS system can best support the design process, and will be the subject of empirical evaluation during the project.

2.3 A USER-CENTRED/PARTICIPATORY DESIGN PROCESS

To ensure maximum uptake of, and value gained from the TRENDS system it is important that it is well matched to the intended users, contexts of use, and tasks. For this reason, a user-centred approach to system development will be adopted. This will involve detailed examination of the nature of the individuals who will be using the system (e.g., abilities and preferences), the nature of the tasks that they will be performing (e.g., task components and performance sequences), and the contexts in which those tasks will be performed (e.g.,

organisational requirements, norms, or practices). Tests will be performed, throughout the development process, to provide detailed assessment of the performance of the system and its acceptance by end-users (industrial designers). In this way a system with high 'usability' can be developed (see Nielsen, 1993). The 'usability' of computer systems is generally regarded as a multi-dimensional property. Fundamental components include: i) effectiveness – the extent to which the user can achieve their task goal; ii) efficiency – the resources required (e.g., time and effort) to achieve a goal; and, iii) satisfaction – whether the user finds the system satisfying in use (see e.g., ISO 9241). Although other factors such as ease of learning how to use the system and the extent to which functions can be remembered can also be considered (see e.g., Wixon & Wilson, 1997), and recent work has considered more detailed affective responses to software (see Hassenzahl and Tractinsky, 2006, for a brief overview). For the TRENDS system, a further important consideration is the extent to which creative processes are supported. Creative outcomes can be difficult to assess. However, consistent with the industrial design process, peer and management judgements will provide an important metric when such judgements are required for the TRENDS project.

Consideration of these factors as an integral part of the process of system design will help to ensure that it will be of high quality, easy to use, and satisfying to use (see ISO 13407). However, in addition to gathering data from end users, where possible they will participate more directly in the TRENDS system design process. A participatory design approach requires the 'active participation of end users rather than simply using end users as a source of data (Muller, Haslwanter, & Dayton, 1997). Benefits of such an approach include greater efficiency in the design process, better design quality, and greater commitment to new systems by end users (Muller *et al.*, 1997). To this end, two companies that engage in car design are members of the TRENDS project consortium (Style Bertone and Centro Richerche Fiat). An additional pool of car designers from UK and Germany has been recruited to take part in some developmental activities, and students from industrial design-oriented course in the UK are being recruited as experimental participants. As the project progresses other fields of industrial design will be examined and further designers will be recruited to take part in the project.

2.4 AN ITERATIVE DESIGN PROCESS

To ensure a systematic progression towards the overall goal and that end users have the opportunity to contribute fully to the design process, an iterative approach to design will be used for the TRENDS project. This will be loosely based on the Spiral model proposed by Boehm (1988, see Figure 2). In this model, each loop is a development stage, and the progressive approach enables the reduction of risks in software development. A key advantage in approaching a complex project in this way is that the major risks are resolved at an early stage, before significant costs are accrued. This can be related to a data gathering process in which information provides the basis for risk assessment. User testing will form a key part of risk assessment and resolution.

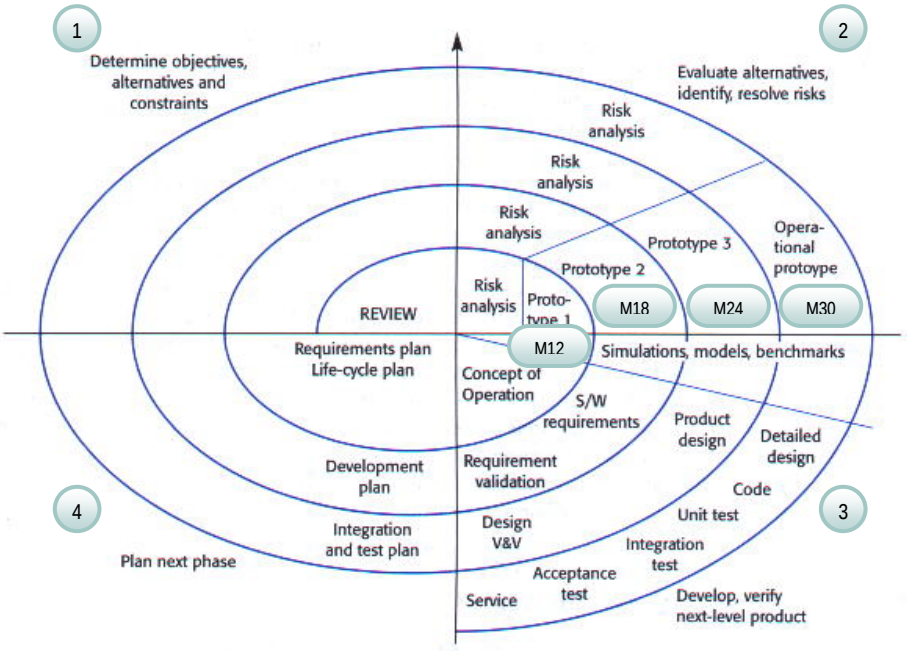

Figure 2: The Spiral Model (Boehm, 1988)

A series of iterations will occur that consist of the following activities performed in sequence:

1-setting objectives: defining objectives and constraints for the loop;

2-identifying and evaluating alternative means for achieving objectives; (risk assessment and reduction - identifying the risks associated with activities and decisions within the loop, and taking steps to reduce those risks. For example, a user interface prototype might be used to reduce the risk that the specification for the interface does not satisfy user requirements);

3-developing and testing prototypes;

4-reviewing the iteration and planning of the next stage of development.

As part of the development process, it is important to be able to set design goals and system specifications that can be assessed. In this way it will be possible to determine when design goals have been met (ISO 9241). However, with complex 'interactive end-user applications' problems can arise with over-specification at early stages of a project (Boehm, 1988). Over-specification can lead to a lack of flexibility in addressing issues that have been raised by users during the development process of that arise from other user-related data. For these reasons a balance will be sought in the TRENDS project, with specifications becoming increasingly detailed as the project progresses.

In the TRENDS project four different prototypes will be tested by the end-users:

Prototype 1 (M12): Prototype 1 is the first interface prototype and non-interactive function. It follows the functional specification and its translation into design concepts. This prototype is a PPT version without any algorithmic development *(see TRENDS D2.4 First version of the graphic interface and its description)*. It is the first concrete expression of the end users needs and of the main functions coming from the Conjoint Trends Analysis method. This interface is not interactive and this is what distinguishes it from later prototypes.

Prototype 2 (M18): Prototype 2 is the first version of the components prototype. As components, it includes the User interface of text and image search, the User interface for ambience and pallets, the User interface for the intelligent agent search and results and the Intelligent web agent software.

Prototype 3 (M24): Prototype 3 is the full prototype integrating the previous components *(see D3.4 First prototype of user interface, D4.4 User interface for visual text and image search and ambience and pallets, D5.3 User interface for the intelligent agent search and results, and D5.5 Intelligent agent software).*

Prototype 4 (M30): Prototype 4 is the operational prototype: it is the final version of the software. It will be delivered as *deliverable D6.2 Final version of the software*.

3. USER TESTING: METHODOLOGY

A variety of methods will be employed as part of the programme of user testing. These will include both qualitative and quantitative methods. The use of qualitative methods will tend to be more frequent in the early stages of the project, when more general information seeking is required as part of the process of formulating precise research questions, i.e., scoping problems and defining issues. In the latter stages of the project quantitative methods will predominate, as these will enable more precise system testing and permit some generalisations to be made on the basis of test results. This is broadly consistent with the distinction between formative and summative testing (Karat, 1997).

Experimental tests will be selected to provide information on risks (consistent with the Spiral model: Boehm, 1988). Each test may focus on specific features of the system or the design process. It is important that tests reflect actual use situations as closely as possible, i.e., that the testing situation is well matched to the 'real world' situation in terms of the nature of the user, the type of task, and the context of performance. Data gathering early in the project will be designed to provide analyses of users, tasks, and contexts of use.

3.1 METHODS OF DATA COLLECTION

Several types of data collection will be employed throughout the ongoing development of the TRENDS system. This is generally held to be advantageous in the context of usability testing (Karat, 1997). All evaluation methods have advantages and drawbacks. The selection of an appropriate range of methods allows weaknesses in one to be compensated for by strengths in another.

3.1.1 Semi-structured interviews

An interview provides the opportunity to obtain qualitative data from participants in a relatively unconstrained manner. This is particularly useful in the early stages of system development when problem boundaries have not been (fully) established. However, lack of consistency in the material covered in different interviews (e.g., with different designers) can be problematic, and make comparisons difficult. A semi-structured interview improves on this position, permitting greater consistency in the contents of interviews across a series of interviews. Typically, for semi-structured interviews, interviewers have a list of topics, or items, to which they want responses, but they have freedom in the sequencing of questions (Powney and Watts, 1987). They also allow participants to introduce new concepts into the discussion. As with all self-report methods, there are some associated drawbacks. First, it may be that some aspects of task performance are not available for conscious introspection. Some highly practiced task components are performed without requirement for attention (Schneider & Shiffrin, 1977). For example, it is difficult to explain to someone how to ride a bicycle. Second, it may be that participants attempt to rationalise their behaviour, for example, reporting particular problem solving sequences because they seem to 'make sense' rather than because they are an accurate reflection of how they approach the problem. Third, it may be that reports are consciously or unconsciously biased. This might reflect, for example, the interviewee wanting to 'help' the experimenter with their answers. However, it has also been shown that self report can be biased by factors of which we are not consciously aware (e.g., Nisbett & Wilson, 1977).

For the TRENDS project researchers will use semi-structured interviews to gather information on the tasks that designers perform and to gather views on the functionality and implementation of the trends system. The structure adopted and questions included will depend on the specific design issues under consideration. However, the format will remain relatively open to allow designers to introduce previously unconsidered points. Researchers will have the opportunity to follow up any interesting points. Interview sessions shall be video or audio recorded for later analysis. The data obtained may require translation to English in the form of a written dialogue.

3.1.2 Storyboarding

Storyboards are an inexpensive form of prototyping. They tend to be used at early stages in the process of system development, at which point they facilitate visualisation and therefore early evaluation of a system. Taking the form of a sequence of images (and perhaps words) they can be used to represent the system at different levels of abstraction (see Rasmussen, 1986). So, they might illustrate system functionality in a rather general manner, but could also illustrate the process of interaction, as it is envisaged at that time, in some detail (see Lelie, 2006). In this way they can be directly of benefit to system designers, facilitating their consideration of the 'consequences' of certain design decisions. However, they are also a useful adjunct to interviews, questionnaires, or focus groups as a means of eliciting users' views of a proposed system. Results of storyboarding can be fed back into the design process in an iterative manner.

For the TRENDS project, storyboards will be used to support the process of eliciting the views of industrial designers with respect to the functionality and specific implementation of the TRENDS system. They will be used in conjunction with semi-structured interviews and questionnaires.

3.1.3 Questionnaires

Data gathered via questionnaires is subject to the usual limitations associated with self report (see above). However, this method also provides an inexpensive and standardised means of obtaining data from participants. Depending on the format of the questionnaire, data can be suitable for quantitative analysis.

There are a number of questionnaire measures that have been designed specifically to test system usability (e.g., Isometrics, SUMI). These might prove useful in the later stages of system evaluation. However, there are many unusual features about the TRENDS system that are best dealt with by means of purpose designed questionnaire measures. For example, we are interested in users' assessments of the inspirational value of materials (images) that they retrieve when using the TRENDS system and representations of data (image) summaries that may be presented. The inspiration value associated with retrieved materials is an important outcome for designers. Related to this and consistent with the discussion, above, regarding the potential importance of diversity as part of the creative process, it is important to consider the semantic distance between retrieved information and: i) the search terms used; and b) the intended design. This will be assessed using rating scales. Often it will be appropriate to obtain assessments of semantic distance from samples of participants who have not performed the information retrieval task.

Users' satisfaction is typically held to be a component of usability (ISO 9241). This would usually be assessed using a self-report method. More recently, extensions to this model of usability have been proposed such that a range of affective responses (e.g., pleasure, flow) are included (see Dillon, 2001; Hassenzahl & Tractinsky, 2006). Various models of emotional response have been proposed. A major distinction is between dimensional models (e.g., Mehrabian & Russell, 1974) and typology models (e.g., Ekman, 1982). In the context of the TRENDS project, emotional response is important in relation to both the system and also retrieved materials. In many instances a series of judgements of affect will need to be made by participants. To facilitate this, the Self Assessment Manikin (Lang, 1985) will be used. This self-report instrument is based on a three-dimensional model of emotion (pleasure, arousal, and dominance), but requires the participant to make just one assessment per scale, using three series of cartoon characters each depicting variation on one of the key emotion dimensions (see Mehrabian & Russell, 1974).

3.1.4 Verbal protocols

Verbal protocols require that participants perform a task of interest, using the system under development, while giving a 'running commentary' on their actions and motives. This can be particularly useful in developing an understanding of the cognitive (unseen) processes that are involved in task performance. However, participants

sometimes find concurrent verbalisation difficult to achieve. There is also the danger that the addition of the verbalisation task will force participants to restructure their performance of the main task. Also this method is subject to the deficiencies more generally associated with self-report methods. Nevertheless, verbal protocol methodology may be used at different stages of the TRENDS project to obtain a more detailed understanding of the cognitive processes that industrial designers engage in.

3.1.5 Gathering user performance data

User performance data is useful for summative evaluations and comparisons of different design alternatives or performance under different conditions. It can be used, in the context of an iterative design process, to facilitate the comparison of the system at different stages of development. Performance measurement can take many forms. In the context of usability evaluation (see e.g., ISO 9241) measures of effectiveness and efficiency would be taken. Effectiveness refers to the extent to which the users' goals can be achieved, so measures would include performance accuracy (e.g., number of errors). Efficiency refers to the level of effort that is required to achieve goals, so measures would include speed of task completion, but could also include self-reports of workload.

In addition there are metrics associated with information retrieval that may prove useful. When evaluating the quality of information retrieval systems, precision and recall are two measures that are often considered (see Baeza-Yates & Ribeiro-Neto, 1999). For a given information search within a database, the measure of recall is an index of the extent to which all relevant items were included in the retrieved set. Precision is an index of the extent to which only relevant items were included in the retrieved set (i.e. there was no unwanted material).

Performance measures can be gathered under different circumstances. There are advantages associated with gathering data under controlled experimental conditions. This provides the possibility of focusing on specific features of the system, in the absence of the statistical 'noise' that is created by random variations on other associated variables. For example, by using controlled experimental conditions it will be possible to get participants to perform searches in the same database, whereas 'real world' task performance would not be so constrained. However, there are also advantages associated with gathering data in less controlled applied contexts. In this circumstance ecological validity is greater along with confidence that results will generalise to 'real world' use.

For the TRENDS project some controlled experimental studies will be conducted, allowing tight focus on specific research issues. However, often an amalgam of these approaches will be adopted. Confidentiality issues will always make 'real world' testing difficult. However, the importance of context should not be under estimated (Karat, 1997). For this reason, participants will be asked to perform simulated tasks that have been matched, insofar as is practicable, to 'real world' task context. Information gathered during WP1 will form an important basis for determining appropriate context. So, for example, in experimental studies participants may be given a design brief, similar to that provided at the beginning of a design task, and asked to use this as the basis for a search for inspirational materials.

Background logging of user actions can be useful, providing data on the functions that are used and sequences of interaction. This can be helpful in determining the priority of system components, where users are having difficulties, etc. For later prototypes in the TRENDS system background logging facilities will be made available. This will provide the facility for the system to test in applied settings, with unconstrained use by designers, while maintaining a record of frequency, sequence, and speed of use, for the various functions of the system.

3.2 PROTOCOLS FOR DATA GATHERING

Good experimental practice is about using the selected methods of investigation in an appropriate manner.

The selection of methods is based on the types of answers we are hoping to find, this is usually moderated by what is achievable within the time and resources allocated. Pilot testing in advance of main tests to ensure suitability of materials is essential (Robson, 1993). Pilot testing will identify any inevitable problems of converting design into reality. Where testing is conducted in more than one location and by more than one researcher (perhaps in different countries) it is extremely important that experimental protocols are exactly matched. For example, instructions to participants and the conduct of the experimenter should be the same in all settings for a given test. In this way data can be pooled for analysis (in addition to separate analyses that may focus on cultural or organisational differences).

3.2.1 Data handling procedures

It is essential for certain information to be recorded clearly and consistently with all types of data. Failure to do this may make it difficult at later stages in the project. It is often necessary to return to the data a long time after it has been collected in order to follow-up observations or discoveries that only become evident as the project progresses. Furthermore, the worker who collected the data may not be the worker who analyses it, in order to overcome such potential problems it is necessary to make diligent records with each set of observations regarding the following:

- The date on which the data was collected
- The name of the data collector
- The TRENDS partner to which the data collector belongs
- The site of where the data was collected
- The name of the study
- A clear and concise description of the all the details of the study
- An anonymous identification number

All data will be stored at the site at which it is collected. It will be well organised in an appropriate manner so that data retrieval is quick and easy. Confidentiality of participants will be maintained at all times. Backups of electronic data must be made to avoid loss due to disk/memory malfunction. When gathering data, backups should ideally be made at the end of testing each participant. If, for any reason this is not practicable, backups should be made at the end of each testing session.

3.2.2 Language

Gathering and processing data is complicated by the fact that data will be gathered in different countries and in some instances materials will need to be presented in different languages. For the purposes of storage, analysis, and dissemination, where necessary, all materials/data will be translated into English.

3.2.3 Data formats

For most parts of the project data should be gathered and stored electronically as this will make later analysis and transmission between project sites easier to achieve. However data methods of paper, video and audio will also be used.

- Paper based – Researchers should be careful to use clear handwriting that remains so even after faxing and photocopying. Data sheets should be well organised, preferably according to prepared templates. All paper based documents should include the date, TRENDS partner site and sufficient information which clearly detail the purpose of the data gathering procedure in order for the data to be understood by other workers.
- Computer-based – Researchers will use Microsoft Excel and SPSS for data recording and analysing purposes. These will include questionnaire responses, spreadsheets, etc. All data will be clearly marked using appropriate file names and will be stored at researcher TRENDS partner site. All data

will be stored safely on individual partners secure servers. Analysis of data will be done using Microsoft Excel and SPSS and all TRENDS reports will be done so using Microsoft Word.

3.2.4 Transfer of data between sites

Transfer of data between sites will depend upon the nature of the data to be transferred.

- Digital data will be transferred electronically via the internet
- TRENDS website hosts a "validation zone" where TRENDS documents are easily accessible
- In order, to protect participant confidentiality, no personal data will be sent.

3.2.5 Ethics

Participants will be informed of the purpose of each study prior to commencement and informed that they are free to withdraw at any time. Participant anonymity will be protected by allocating codes for the storage of raw data. A separate database cross-referencing participants' personal information will be held by the researchers whilst the data is written up and for a short while after this. All computer-based data will be stored in a secured folder, and to which access is only permitted to the researchers working on the study. If participants agree, their contact details may be retained so that they can be contacted to take part in future studies. Some of the data may be gathered from professional car designers at their place of work. The researcher will inform someone in the department of their plans (place of study and time schedule). It is not considered that this poses any undue risk top the researcher.

3.3 PERSONNEL RESOURCES

This work will be led by ENSAM who will coordinate resources and activities. SERAM will also conduct usability tests in order to propose design and ergonomics specifications. UNIVERSITY OF LEEDS will play a major role in the component of the project, contributing to the design of the usability testing process, conducting usability studies, and gathering related information from designers. ROBOTIKER is responsible for developing the user interface. This will include the development of a series of prototypes for usability testing. Designers from CRF and STILE BERTONE will contribute directly to the development process, attending project meetings and commenting on project objectives and prototypes. They will also be available for testing the system prototypes. Other partners (INRIA, CARDIFF, PERTIMM) will be responsible for developing prototypes in line with the project objectives, and as specified at each iteration of the development process. More specifically, PERTIMM will lead the development of the mixed text and image search algorithm with INRIA, and of the development of the intelligent agent with the UNIVERSITY OF CARDIFF. INRIA is responsible of the development of the signature extraction algorithm for mono-sector, ambience and pallets. ROBOTIKER is in charge of the development of the three related interfaces and finally their integration into the full prototype. For each of these three technologies, a temporary interface different from the one implemented after the full integration will be needed to test the different algorithms and data flows. This means that the component prototype is not a user friendly interface but more a technical validation interface. It precedes the elaboration of the whole user interface for the complete system, from the web search, the local search to the pallets and trend boards. The whole user interface corresponds to the integration of the three technologies into the full prototype. In parallel the end user evaluation will aim to show the practical applicability of the TRENDS prototype within an industrial environment with a sufficient complexity to show all general advantages of the architecture. The evaluation will be based on two main tasks which are on one side the analysis of the activity of the end users, and on the other side the final validation of the design and ergonomics with end users. CRF and STILE BERTONE will operate the final validation of the overall system, express comments and feed back for the final prototype modification and will also conduct these evaluations among their collaborators.

4. SCHEDULE FOR TESTING

The development of the TRENDS system will comprise three iterative cycles and a finalisation phase. The structure of the development process is loosely based on Boehm's (1988) spiral model. In this section of the report we specify the objectives of each of these iterations; provide some information on the methodologies that will be used in achieving these objectives; set out the timescale for these activities; and identify any foreseeable risks associated with their completion.

These iterative cycles will apply to all project partners. They will specifically allow for user feedback and information from user tests to be incorporated in the design component of each iterative cycle. However, in addition, a parallel programme of 'satellite' development work will take place, allowing further (and more flexible) work on system components. This additional work will be restricted to 'proof of principle' or 'housekeeping', including the conduct of user tests and the development or refinement of system architecture that does not impact on the user experience. This approach will mean that a strict iterative approach can be adopted for the main system development, but that all partners have the scope to be able to remain active at all stages of the project (i.e., there are no periods of delay for any partner while waiting for the results of an earlier phase).

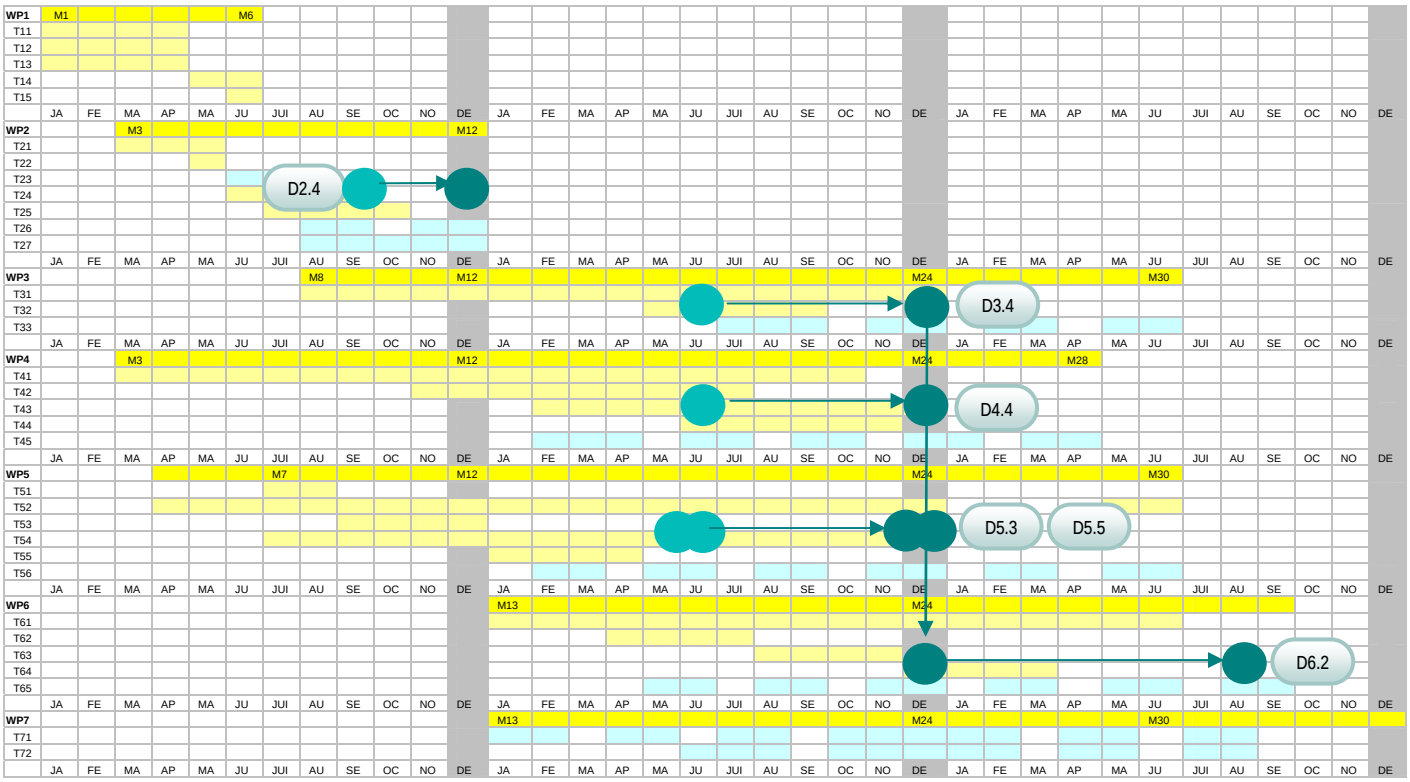

Table 1: Time table for the TRENDS project

The user-centred approach started with the WP1 initial end-users analysis being the base for the functional specifications. Besides a testing session was planed at the end of each work package (See T2.6, T2.7, T3.5, T4.5, T5.6, T6.5) before the deployment of WP7 which is wholly dedicated to end users evaluation. It starts the M13 after the achievement of the first version of the graphic interface and non interactive function (PPT version). Every user testing and validation tasks are shown in blue. As it is mentioned, the evaluation by the end users is continuous and covers the whole prototypes development. Overall the test will be led in correspondence with the elaboration of the following prototypes represented by blue round shapes on the figure:

Prototype 1 - Interface prototype and non-interactive function (M12): *D2.4 First version of the graphic interface and its description)*.

Prototype 2 - Components prototype (M18): *No corresponding deliverables.*

Prototype 3 - Full prototype (M24): *D3.4 First prototype of user interface, D4.4 User interface for visual text and image search and ambience and pallets, D5.3 User interface for the intelligent agent search and results, and D5.5 Intelligent agent software).*

Prototype 4 - Operational prototype (M30): Prototype 4 is the operational prototype: it is the final version of the software. It will be delivered as *deliverable D6.2 Final version of the software*.

4.1 ITERATION 1: GRAPHIC INTERFACE AND NON-INTERACTIVE FUNCTION

This iteration involves the specification, development, testing, and evaluation of the initial graphic interface (PPT). It is currently in progress.

4.1.1 Objectives

The objectives of this stage are:

1. To develop an understanding of the industrial design task (in a car design setting) and designers requirements of the TRENDS system (including views on CBIR and Conjoint Trends Analysis).
2. On the basis of [1] to set objectives and document requirements specifications.
3. To develop interface proposals
4. To evaluate the solutions on the basis of evidence gathered.
5. To plan the component prototype

The final output of this iteration will be a set of specifications that are sufficiently detailed to provide the basis for the development of the first interactive component prototype of the full TRENDS system. These specifications will include indications of standards of system performance (e.g., search accuracy) that should be achieved that can be used as a basis for testing in subsequent iterations. However, sufficient flexibility should be maintained to allow for modifications based on further end-user input to the design process in subsequent design iterations.

4.1.2 Tasks and methodology

A/ Interview designers (T1.1)

The very first steps of TRENDS project were aimed at understanding end-users activity in the very early stages of the design process. LCPI-SERAM and UNIVLEEDS members prepared “sensitizing booklets” that were e-mailed to the future interviewees; by filling in the booklets, the participants were invited to explain their tasks related to the use of any design information in the early stage of a project: for instance, they had to list their various sources of visual information and sources of inspiration; they had to draw mindmaps explaining which creative sectors influence them in their job (whose sector is: “car-design”)… After having collected this information, LCPI-SERAM and UNIVLEEDS met CRF and BERTONE end-users for live interviews. 32 end-users from design, marketing or R&D departments were interviewed about the topics that were firstly addressed in the written booklets. The users’ current way of working, as well as their expectations, expressed in the interviews allowed to set up a list of functional requirements (D1.4 deliverable) expected to be fulfilled in TRENDS system further developments. Besides, the end-users activity analysis allows the identification of relevant sectors of influence for the car-design activity. The interviews outputs are detailed in the D1.1 deliverable.[1]

[1] All TRENDS deliverables are available on the project official website www.trendsproject.org, either in the public or in the private area depending on the deliverable classification.

B/ Review literature – state of the art and benchmark (T1.2, T1.3)

LCPI-SERAM and CRF reviewed literature about existing tools in the same domain as TRENDS tool, i.e. about computational tools that support the search of visual and lexical information, especially when they integrate the users' subjectivity ("Kansei"). This state-of-the art listed the trends in research about the informational tools for the very early stages in product design process: this research domain is quite emergent and it shall integrate cutting-edge technological proposals. In parallel to these research review, a benchmark was carried out about the existing tools that are currently used at end-users' companies to search for information about trends and design elements. The state-of-the-art is detailed in D1.2 deliverable and the benchmark in D1.3 deliverable.

C/ CTA evaluation (T2.6, T2.7)

Task 3 consists in obtaining views from designers on Conjoint Trends Analysis (CTA) prior to the development of a computer-based implementation. Considering that the Conjoint Trends Analysis method is an emergent method in the field of car design, the functionalities coming directly from this approach will be presented to the end-users under the form of a first interface prototype (in a PPT not developed version), in a concrete form, before to test the usability.

Participants for this data gathering process will be a sample of designers from the project partners (SB and CRF) and also a sample of UK and possible German designers, recruited by UNIVLEEDS. A series of semi-structured interviews will be conducted with pairs of designers. 'Storyboarding' methodology will be used (Lelie 2006), such that a PowerPoint presentation showing images of the process of using CTA, including simulated inputs and outputs, will be developed. This will assist designers in visualising the possibilities of the system. Designers will be asked for their impressions of the system, for suggestions regarding improvements to the concept, for suggestions as to the most appropriate system interface.…

Following this task, we expect to get a preliminary usability evaluation of the future system, and collect users' needs and recommendations with respect to the development of the interface. Moreover, we will be able to question users on the potential usefulness of the future system. Designers will be asked for their impressions of the system, for suggestions regarding improvements to the concept and the functions offered, and for suggestions as to the most appropriate system interface.

D/ Semantic and emotional evaluation (T2.6, T2.7)

The first evaluation of graphic style was performed before the development of the interface, by testing some graphic elements coming from the task *T2.4 Graphic Interface 1st Design Elements* built on both functional requirements list and creativity session by TRENDS partners. This study concerned end-users from CRF and SB. The first graphic elements for the interface, i.e. 3 interface proposals, were presented with screenshots. An online questionnaire, for the 3 proposals evaluation, was reachable through an URL address.

Users were provided with the online questionnaire. They were invited to fill it in individually. It took around 15 minutes to fill it in. The questions were based on the SAM method ('Self Assessment Manikin') adapted to an interactive tool evaluation, i.e. evaluating 'valence' and 'intensity' of emotions felt by users. Besides, users were asked to quantify their feeling with regard to several semantic and emotional descriptors.

Each completed questionnaire was received as an automatically e-mailed file to LCPI-SERAM.

The expected outcomes of semantic and emotional evaluations are to evaluate users' perception of the graphic style of the future TRENDS system, and to identify their preferences (definition of the ideal interface) in order to develop a system matching as closely as possible their preferences.

New testing dimensions will be added at the stage of the first version of the graphic interface, where the prototype will be more detailed: the aesthetics, the coherence, the conviviality, and the attractivity.

4.1.3 Timescale

This iteration at the outset of the project and will be complete by December 2006 (M12).

4.1.4 Risks to be resolved

- That designers will not find the system sufficiently well matched to their requirements
- That designers will not appreciate the value of the system
- That designers will find that the system is not useful
- That the quantity of information resulting from the search is too low
- That the system will not be used by marketing and R&D people
- That the system will be considered as too constraining for the designers
- That designers will not have pleasure in using the system
- That the resulting information will be judged as not relevant enough (linked to freshness, quality, precision and detail level)
- That the system will not be easy to use
- That the system will not be intelligible
- That the automatic updating capacity will be considered as too low

4.2 ITERATION 2: COMPONENT PROTOTYPE

4.2.1 Objectives

This iteration involves the specification, development, testing, and evaluation of component prototypes.

The component prototypes that will be developed will be tested with designers. The component prototypes developed should take into account the information gathered in WP1 and in WP2 with respect to the nature of the user, the task, and the context. They should be interactive.

1. To develop the components of the system.
2. To develop computer-based algorithms and software that will support components of the system.
3. To test these components, gathering data from end users.

4.2.2 Tasks and methodology

A/ Semantic and emotional evaluation (T6.1)

A new evaluation of graphic style of the interface will be carried out when system architecture development is more advanced and when a real TRENDS prototype is usable. In comparison to the protocol previously described (see Iteration 1), we may add a 'dominance' scale to evaluate to which extent users feel in control of the system. Otherwise the procedure will be the same as for iteration 1.

B/ Usability evaluation (T3.3, T4.5, T5.6, T6.1)

Usability studies will be conducted with the first version of the TRENDS system implementing one or several features such as the search engine or the intelligent agent (beta release). Users will first be submitted to a free exploration of the system. Then they will be given a few short and precise scenarios to achieve, for example:

- "please compose a pallet from the XYZ database"
- "please collect pictures of chairs with round-shaped backrest"
- "please find pictures of black aggressive cars"
- "please collect information about the lifestyle of female drivers in their 20's"
- "please convey to your colleague this collection of data"
- …

Log files of the system will be saved in order to get a performance measure and to detect possible bugs. The sessions will also be video-recorded in order to analyze users' behaviour (spontaneous tries, exploration, errors, hesitations…) and verbal comments. Finally, users will be invited to answer a usability questionnaire. User profile will be carefully collected in order to investigate individual differences in performance, behaviour and subjective

evaluation of the system.

Such usability test will enable us improve the interface of the system, as well as the technologies of TRENDS (e.g. CBIR). Moreover, it will enable the team to collect an evaluation of the TRENDS system functionality (feedback to functional requirements defined in deliverable D1.4) and of the potential usefulness of the system.

4.2.3 Timescale

This iteration will be completed by June 2007 (M18).

4.2.4 Risks to be resolved

- Poor implementation
- The interface is not satisfying for the user
- The text search speed is not quick enough
- The image search speed is not quick enough
- The number of relevant images or texts is not enough
- The semantic approach is not relevant
- The time of grabbing is too long
- The time of image indexing is too long

4.3 ITERATION 3: FULL PROTOTYPE

4.3.1 Objectives

Development of second prototype based on the outcome of Iteration 2. This prototype is the full prototype integrating the previous components. It will be tested with designers. Testing will take place in other industrial design settings (not just the automotive sector).

4.3.2 Tasks and methodology

Global use study (T6.1, T6.2)

These studies require a full-functional version of the TRENDS system. Global use studies will offer results complementary to those of iteration 2 and enable us to measure the improvements brought on the system.

Users will have to perform global scenarios involving storage, search and collaboration functions, for example:

- "please compose a multimedia collection for the following design brief"
- "please convey to your colleague a selection of your favourite pictures"
- Peer-tutoring: "please teach your colleague how to use the TRENDS system"
- …

Log files will provide a performance measure, while video-recordings will enable us to conduct a behavioural analysis. Subjective evaluation will be inferred from verbal comments and from the answers to a questionnaire (on the usability and preferences dimensions). User profile will also highlight individual differences in these measures.

4.3.3 Timescale

This iteration will be completed by December 2007 (M24).

4.3.4 Risks to be resolved

- The design of the interface is not satisfying
- The speed for image query is too long (it must be under 10s)

- The system is not useful enough (it must be 90% at least)
- The system is not easy to use
- The system is not comfortable to use
- The position of the information on the screen is not relevant
- The information is not fresh enough
- The semantic approach is not relevant
- The number of images inspected in every cycle is too low
- The number of successful searches is too low
- The costs of licences are not adapted
- The costs of the whole system are not adapted
- The number of user requirements implemented by the software is not sufficient

4.4 ITERATION 4: OPERATIONAL PROTOTYPE

4.4.1 Objectives

Final adjustments based on results of Iteration 3.

4.4.2 Tasks and methodology

Comparative study (T6.1, T6.2)

Comparative studies will concern end-users as well as expert users of trendboards and will require a full-functional version of the TRENDS system.

The goal of these studies will be to compare classical ways of working with the use of the TRENDS system, in order to investigate the usefulness dimension. Users will have to perform several scenarios, for example:

- They will have to provide an old collection previously composed for a given design brief. Then they will have to make a new collection for the same design brief, by means of the TRENDS system.
- They will be given 2 new design briefs and will be asked to build 2 corresponding collections: one with traditional methods, the other one by means of the TRENDS system. The counterbalanced assignment of design briefs and working methods (see table below) will allow us to compare the collections made with / without the TRENDS system.

	Design brief A	**Design brief B**
User 1	Traditional methods	TRENDS system
User 2	TRENDS system	Traditional methods
User 3	Traditional methods	TRENDS system
User 4	TRENDS system	Traditional methods
…	…	…

Table 2: Example of assignment of design briefs and working methods

We will conduct a task analysis of traditional collection building and TRENDS collection building (requires a video-recording of the sessions). Besides, performance on the TRENDS system will be assessed from the log files, and subjective evaluation by means of a questionnaire. The collections composed for the design briefs will be evaluated by the designers themselves (peer-rating).

These studies will provide tangible data on usefulness issues (e.g. Does TRENDS system enable to build more original / relevant / consistent / expressive / harmonious multimedia collections?), and complement the previous studies (enabling new improvements).

4.4.3 Timescale

This iteration will be completed by June 2008 (M30).

4.4.4 Risks to be resolved

- Problems are identified for which insufficient project resources remain for resolution.
- Small interface problems present barriers to uptake
- The utility of the system will not be found in other industrial design environments
- Different requirements will be identified in other industrial design environments

5. CONCLUSION

This document sets out a framework for user testing that will apply to the remainder of the TRENDS project along with a timescale that will guide this. All project partners will actively engage with this research programme, schedule their activities accordingly, and abide by the constraints. The development of the TRENDS system will follow a user-centred and, where possible and appropriate, participatory design process. Research partners STILE BERTONE and CENTRO RICHERCHE FIAT will make a major contribution in this respect, with their designers participating in the research process. However, user testing will extend beyond this to examine the generalisability of the TRENDS system components to other design environments.

The iterative design process, described above, includes four system development cycles. Although some 'satellite' development work is possible, all partners will adhere to the timescale of the iterations. Project design meetings, with representatives from all partner organisations will be convened at the end of each cycle to review the information gathered during that cycle and, on the basis of this, to plan the design process for the next cycle. It is obviously important that partner organisations do not 'out pace' this development process in their individual development work. System development will be guided by these design meetings rather than the simple expedient of 'what has already been achieved'.

A number of specific data gathering methodologies are described in this document. These will be the key methodologies adopted by the TRENDS project. They include an appropriate variety of methods, allowing information to be gathered appropriately according to the particular stage of the design process and for data to be gathered from different 'perspectives' on particular design problems. Of relevance in this respect is the inclusion of qualitative and quantitative methods and the use of self-report methods and assessments of user performance patterns and abilities. The list is not intended to be exhaustive and does not preclude the addition of further method(s) if the needs of the TRENDS system development process justify their inclusion.

Protocols for data gathering and handling are included in this document. The intention is to set out guidelines that will ensure good practice, safeguard the rights of participants, and facilitate the transfer of information between project partners.

6. REFERENCES

1. ANSBURG PI, HILL K, Creative and analytic thinkers differ in their use of attentional resources, PAID, Vol 34, Issue 7, May 2003

2. BAEZA-YATES, R. & RIBEIRO-NETO, B. (1999). Modern Information Retrieval. Harlow: Addison Wesley.

3. BOEHM, B. (1988). A spiral model of software development and enhancement. IEEE Computer, May, 61-72.

4. BLACK JA, KAHOL KANAV JR, PRIYAMVADA T, KUCHI P, PANCHANATHAN S, Stereoscopic Displays and Virtual Reality Systems XI. Edited by Woods, Andrew J.; Merritt, John O.; Benton, Stephen A.; Bolas, Mark T. Proceedings of the SPIE, Volume 5292, pp. 363-375, 2004

5. BONNARDEL & MARMECHE (2005), Towards supporting evocation processes in creative design: A cognitive approach. International Journal of Human-Computer Studies 63, 422–435

6. BOUCHARD C., CHRISTOFOL H., AOUSSAT A., AUVRAY L., ROUSSEL B., 1998, How to anticipate trends and integrating trends into industrial design, ICED 1999, Munich, 7 p.

7. BOYLE, T. (1997). Design for multimedia learning. Prentice Hall, London.

8. BUTCHER, H. J. (1972). Divergent thinking and creativity. In W.D.Wall & V.P. Varma (Eds). Advances in educational psychology. Vol.1. London. University of London Press, Ltd.

9. CROCKENBURG, S. B. (1972). Creativity tests: A boon or boondoggle for education. Review of Educational Research. 1, 42, 27-45

10. DAVIS, G. A., & BELCHER, T. L. (1971). How shall creativity be measured? Torrence tests. Developmental Psychology. 6, 119-124

11. DILLON A. (2001), Beyond usability: Process, outcome, and affect in human-computer interactions. The Canadian Journal of Information and Library Science, 26, 4, 57-69.

12. EARTHY, J., SHERWOOD JONES, B. & BEVAN, N. (2001), The improvement of human-centred processes-facing the challenge and reaping the benefit of ISO 13407. International Journal of Human-Computer Studies 55, 553-585.

13. EKMAN (1982) Emotion in human face. Cambridge : University Press.

14. FAUCONNIER, G. & TURNER, M. (1998). Conceptual integration networks. Cognitive Science, 22, 2, 133-187.

15. HASSENZAHL, M. & TRACTINSKY, N. (2006). User experience – a research agenda. Behavior & Information Technology, 25, 91-97.

16. HOCEVAR, D. (1980). Intelligence, Divergent Thinking, and Creativity. Intelligence 4, 25-40

17. ISO 9241: Ergonomic Requirements for Office Work with Visual Display Units.

18. ISO 13407: Human-Centred Design Processes for Interactive Systems.

19. ISO 18529 Ergonomics of human system interaction - Human-centred lifecycle process descriptions.

20. JOHNSON, M.D. (1989). On the nature of product attributes and attribute relationships. Advances in Consumer Research, 16, 598-604.

21. KARAT (1997) Evolving the scope of user-centered design. Communications of the ACM, 40, 7, 33-38

22. KINTSCH, W., WELSCH, D., SCHMALHOFER, F., & ZIMMY, S. (1990). Sentence memory: A theoretical analysis. *Journal of Memory and Language, 29(2), 133 – 159*

23. LANG (1985), P. J., BRADLEY, M. M., & CUTHBERT B. N. (1997). International affective picture system : Technical manual and affective ratings. Gainseville, FL : The Center for Research in Psychophysiology, University of Florida.

24. LELIE, C.V.D. (2006) The value of storyboards in the product design process. Pers Ubiquit Comput. 10: 159–162

25. MAGUIRE, M. (2001) Methods to support human-centred design. International Journal of Human-Computer Studies, 55, 587-634.

26. MEHRABIAN, A. & RUSSELL, J.A. (1974). An Approach to Environmental Psychology. Cambridge, MA: MIT.

27. MITCHELL, AA., & CHI, M.T.H. (1984). Measuring knowledge within a human domain. In Nagy P., Ed. The representation of cognitive structures. Ontario Institute for Studies in Education, Toronto, Canada

28. MOUGENOT C., SOURBE L., BOUCHARD C., WESTERMAN S., AOUSSAT A., TRENDS Deliverable D1.1, List of users specifications, 31/05/06

29. MULLER, M.J., HASLWANTER, J.H., & DAYTON, T. (1997). Participatory practices in the software lifecycle. In M. Helander, T.K. LANDAUER, & P. PRABHU, (Eds.), Handbook of Human-Computer Interaction. 2nd Edition. Amsterdam: Elsevier.

30. NAPHADE, M.R.; HUANG, T.S., Extracting semantics from audio-visual content: the final frontier in multimedia retrieval, Neural Networks, IEEE Transactions on Volume 13, Issue 4, Jul 2002 Page(s): 793 – 810, Digital Object Identifier, 10.1109/TNN.2002.1021881

31. NIELSEN, J. (1993). Usability Engineering. San Diego: Academic Press.

32. NISBETT, R. & WILSON, T. (1977). Telling more than we can know: Verbal reports on mental processes. Psychological Review, 84, 231-259.

33. PANKSY, A AND KORIAT, A. (2004). The Basic-Level Convergence Effect in Memory Distortions. American *Psychological Society, Volume 15, Number 1.*

34. PEREIRA, F. C., & CARDOSO, A. (2002). Conceptual Blending and the Quest for the Holy Creative Process, In *Proceedings of the 2nd Workshop on Creative Systems: Approaches to Creativity in AI and Cognitive Science*, ECAI 2002, Lyon, France.

35. PIROLLI, P. (2003). Exploring and finding information. In J.M. Carroll (Ed.), HCI Models, Theories, and Frameworks. San Francisco, CA: Morgan Kaufmann.

36. POWNEY, J., & WATTS, M., (1987). Interviewing in Educational Research. London Routledge & Kegan Paul.

37. PREECE, J., ROGERS, Y., SHARP, H., BENYON, D., HOLLAND, S., & CAREY, T. (1994). Human-Computer Interaction. Addison-Wesley

38. RASMUSSEN, J. (1986). Information Processing and Human-Machine Interaction. Amsterdam: North Holland.

39. ROBSON, C. (1993). Real World Research: A resource for social scientists and practitioner-researchers. Blackwell, Oxford UK & Cambridge USA

40. ROSCH, E., MERVIS, C.B., GRAY, W.D., JOHNSON, D.M., AND BOYES-BRAEM, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8, 382-439*

41. ROSSON, M.B AND CARROLL, J.M. (2001) Usability Engineering: Scenario-Based Development of Human Computer Interaction. Morgan Kaufmann

42. SCHNEIDER, WE. & SHIFFRIN, R.M. (1977). Controlled and automatic human information processing: 1. Detection, search, and attention. Psychological Review, 84, 1-66.

43. SNELDERS, D. & SCHOORMANS, J.P.L. (2004). An exploratory study of the relation between concrete and abstract product attributes. Journal of Economic Psychology, 25, 803-820.

44. WANG, S. & WANG, X. (2005). Emotion semantics image retrieval: A brief overview. In Proceedings of ACII 2005. Berlin: Springer-Verlag.

45. WIXON D., WILSON C. (1997), (1997). The usability engineering framework for product design and evaluation. In Helander, M. G., Landauer, T. K., & Prabhu, P. V. (Eds.), Handbook of human-computer interaction. 2nd ed. Amsterdam, The Netherlands: North-Holland.

46. WOOD, L. E. (1997). Semi-structured interviewing for user centred design. Interactions.

47. ZHAO, R AND GROSKY, W. I. (2002). Narrowing the Semantic Gap – Improved Text-Based Web Document Retrieval Using Visual Features. *IEEE Transactions on Multimedia, Vol 4, No 2.*

7. LIST OF FIGURES AND TABLES

List of figures

Figure 1: The Conjoint Trends Analysis method 6
Figure 2: The Spiral Model (Boehm, 1988) 9

List of tables

Table 1: Time table for the TRENDS project 16
Table 2: Example of assignment of design briefs and working methods 21

8. GLOSSARY

Conjoint Trends Analysis
The Conjoint Trends Analysis is a recent method based on the externalization and formalization of the cognitive activity of the designers in the earliest phases of design. What is most original in this approach is the identification and use of various domains of influence (nature, arts, industrial sectors, sociological end values) in order to enrich the design solution space. Finally it enables the identification of formal trends attributes (shape, colour, textures) linked to particular environments in order to use them in the early design of new products. It makes it possible to enrich and to inspire the designers and the design team when designing product. It is positioned in the earliest phases of the design process.

Design Trendboards
The Trend boards are iconic compositions that enable to communicate a homogeneous atmosphere both in terms of style and consumers' sociological values. *Design Trendboards* aim to generate exhaustive pallets used in the design phase. These representations include an exhaustive number of sectors.

Iterative approach
The iterative approach used in the TRENDS project is based on the Spiral model from Boehm (1988). In this model, each loop is a development stage, and the progressive approach enables to reduce risks for software development. A key advantage in approaching a complex project in this way is that the major risks are resolved at an early stage, before significant costs are accrued.

Pallets
Pallets are composed of the most significant discrete elements extracted from the ambience and enabling to recognize a specific trend in terms of colours, textures, forms.

Participatory design
Such an approach requires the 'active participation of end users rather than simply using end users as a source of data' (Muller, Haslwanter, & Dayton, 1997).

Trend
Technical / technological and formal evolution led by a transverse inter-sector current which gives to a product its position in the obsolescence cycle.

Usability
The 'usability' of computer systems is generally regarded as a multi-dimensional property. Fundamental components include: i) effectiveness – the extent to which the user can achieve their task goal; ii) efficiency – the resources required (e.g., time and effort) to achieve a goal; and, iii) satisfaction – whether the user finds the system satisfying in use (see e.g., ISO 9241). Other factors such as ease of learning how to use the system and the extent to which functions can be remembered can also be considered (see e.g., Wixon & Wilson, 1997), and recent work has considered more detailed affective responses top software (see Hassenzahl and Tractinsky, 2006, for a brief overview).

User-centred approach
Design method involving detailed examination of the nature of the individuals who will be using the system (e.g., abilities and preferences), the nature of the tasks that they will be performing (e.g., task components and performance sequences), and the contexts in which those tasks will be performed (e.g., organisational requirements, norms, or practices). Tests have to be performed, throughout the development process, to provide detailed assessment of the performance of the system and its acceptance by end-users (see ISO 13407).