A platform for the participatory design

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Résumé. *Cet article décrit une approche instrumentée de la conception participative. Après avoir retracé l'historique et les principes directeurs, une modélisation du processus de conception est proposée en termes de phases, moments et primitives. Les phases sont des séquences à gros grain qui articulent des moments de conception. Ces moments sont bâtis sur des primitives élémentaires et réutilisables. Sur basant sur cette modélisation, l'article décrit l'instrumentation d'une plate-forme d'aide et de suivi de la conception participative orientée usages.*

Mots-clés. *Conception participative, plate-forme d'expérimentation.*

Abstract. *This paper describes an approach for the participatory design. After describing the trends in the domain, a model of the design process is expressed based on phase, moment and primitive concepts. The phases articulate the design moments as nodes and transitions in a dynamic graph. The moments are built on reusable primitives defined as instaciable objects. Then, from this model, the paper details a platform and tools for managing the design process on different points of view: from the user and engineers to the project manager perspectives.*

Keywords. *Participatory Design, Platform for Experiments.*

1. INTRODUCTION

Bernsen (Bernsen, 97) claims that: "It is a well-recognized fact that the production of a new software engineering tool or method is difficult and time consuming. The difficulties lie not only in the initial conception of, for instance, a new tool, or in tool drafting and early in-house testing. Even if these stages yield encouraging results, there is a long way to go before the tool can stand on its own and be used as an integral part of best practice in the field. One central reason why this is the case is the problem of generalization. A tool which only works, or is only known to work, on a single system, in a highly restricted domain of application, or in special circumstances, is of little interest to other developers. In-house testing will inevitably be made on a limited number of systems and application domains and often is subject to other limitations of scope as well. To achieve and demonstrate an acceptable degree of generality, the tool must be iteratively developed and tested on systems and application domains, and in circumstances that are significantly different from those available in-house. Achievement of generality therefore requires access to other systems, corpora and/or development processes. Such access is notoriously difficult to obtain for several reasons, including commercial confidentiality, protection of in-house know-how and protection of developers' time. A second reason why software engineering tool or method development is difficult and time consuming is the problem of objectivity. It is not sufficient that some method or tool has been trailed on many different cases and in widely different conditions. It must also have been shown that different developers are able to use the new method or tool with approximately the same result on the same corpus, system or development process. The benefits from using a new tool or method should attach to that tool or method rather than to its originators."

Since many years, the designers of interactive systems need tools and methods for system design and evaluation. This point is crucial in the industrial context where the constraints are hard to satisfy, due to the variety of resources and competencies to collect, in the area of human factors and sociology. The academic research teams are sought after frequently by the industry for studies on user needs, and on user evaluations. It is important to notice this recent evolution: in the past, the evaluation was done at the end of the cycle of development, now the human factor's specialist acts more lately and continuously during the lifecycle of the system. So, the industry asks to academic teams about new services or competencies as design studies and usability studies (including acceptability and using value or utility).

That is why it would be more benefit, to create a common platform for both academic and industrial partners. This platform would be more a *service centre* devoted to the experimentation than a classical academic or industrial institution facility. These institutions should be clients of this service centre. With this definition, the platform must include: a set of observation rooms, some tools for capturing and analyzing the user behavior, that means a complete usability lab for participatory design. The envisioned industrial benefits of this platform will be:

- Progress towards the integration of systems best practice into software engineering,
- Improved feasibility assurance of development projects (risk minimization) and more exact feasibility assessment,
- Improved procedures, methods, concepts and software tools,
- Reduced development costs and time, improved maintenance and reusability,
- Improved product quality and increased flexibility and adaptability,
- Progress towards the establishment of software engineering standards,
- Improved guarantees to end-users that a product has been developed following best software and cognitive engineering practice. Enabling end-users to objectively assess different systems and components technologies against one another and choose the right product according to quality, price and purpose.

2. THE APLICATION FIELD OF MULTICOM

Increasing importance is being attached nowadays to the ability of ensuring that user interfaces (UIs) behave as expected, as they are being used in more applications where safety and security are critical. Prototyping is the preferred approach to creating UIs because of the need to allow the user to test many of the issues associated with usability. Unfortunately, it is often difficult to verify that prototype-based implementations always behave as expected. In this paper we present the MultiCom platform for the experiment of UI-based applications. MultiCom is an approach to software development which emphasizes the use of operational models throughout the lifecycle. Software development consists, therefore, in building, testing and refining models within a seamless process that leads the analyst/developer from analysis to design and finally to the implementation of the system.

MultiCom is a complete platform for the design and the evaluation of the interactive systems, including all the stages of the development cycle and supporting tools for sociologic observations and ergonomic tests. MultiCom provides tools and assistance to the following steps of the design:

- To observe and diagnose the usage (practices),
- To define the needs, and the style guide,
- To write the test scenario,
- To experiment different test scenarios,
- To simulate the scenarios,
- To refine the specifications,
- To validate the specifications,
- To evaluate the usability.

3. METHODOLOGY

The methodology of MultiCom is based on the observation of situated interaction. A set of users is observed while they are working and their actions are recorded. The results from the analyzed data, provides parameters and constraints for the future design. We envision the following parameters:

- The value and the sense of usage,
- The usability,
- The technological and economical constraints.

Inspection is widely believed to be the most cost-effective method for detecting defects in documents produced during the software development lifecycle. However, it is by its very nature a labor intensive process. This has led us to work on computer support for the process which should increase the efficiency and effectiveness beyond what is currently possible with a solely manual process, but no single tool available fills all the identified needs of inspection.

MultiCom uses several and complementary methods:

- The *predictive method* which starts from cognitive theories and takes into account the technology feasibility in order to help the designer in the specification step,

• The *simulated method* (by virtual reality or by Wizard of Oz technique) which provides data for the specification refinement step,
• The *direct inspection method* on the prototype for the formal validation and the ergonomic evaluation of the system,
• The *indirect analysis method*, as the reverse engineering, which allows checking the system regarding the specifications.

The methodology of MultiCom goes with the design cycle of the system in order to integrate as soon as possible the human factors in the design process (the method is said *user-centered*). The benefit expected is to reduce the time cost of development and to obtain a best quality of the final product. The design cycle runs on three phases:

Information Elicitation and Analysis Phase: this phase involves collecting and analyzing device dependant information (using techniques such as task analysis) concerning the existing tasks of users and the positive and negative features of the systems that they currently use and of other selected systems. The information is then summarized in a device-independent (i.e. high level) task model of the existing systems; the system to be designed is modeled at a similar level based on the Statement of Requirements, i.e. the Project Brief.

Design Synthesis Phase: in this phase, the human factors requirements are established and the semantics of the task domain recorded. A conceptual design for the target system is produced; it is based on the task models produced earlier, and informed by the information collected about the task domain and the human factors requirements. It is then split to separate those sub-tasks that are to be performed using the system under development from those that are performed off-line.

Design Specification Phase: a detailed and device-dependent specification of the user interface is produced; this includes descriptions of the screens, widgets and the interactions. The design is then assessed and refined in an iterative fashion.

More generally, the lifecycle is the following:

A • Observing the use of current systems and predicting the future use with the system to design,
B • Defining the specification notebook,
C • Defining the using scenario and assessing it in situated work with some subjects,
D • Refining the specification on the diagnostic delivered in C,
E • Developing a mock up,
F • Testing the mock up,
G • Evaluating the use and the usability of the mock up,
H • Modifying after debriefing, debugging,
I • Developing another version of the mock up,
J • Returning at the step F while it is necessary,
K • Evaluating the final mock up,
L • Developing a prototype,
M • Pushing it on the market,
N • Training end users if needed,
O • Analyzing the market returns.

This cycle starts generally from an idea proposed by the marketing team. This idea is relatively imprecise: it does not take into account the use constraints nor the technological limits. Therefore, it is necessary to enrich and concretize this starting idea before developing the first model. The steps A, B, C are, in this perspective, a kind of preparatory cycle for testing the feasibility of the idea. Then, the steps D to J are the core of the design cycle running under the trial-error strategy. The step K is critical because it is the decision node before the market proof.

The methodology of MultiCom which goes with the design cycle consists in a set of procedures depending on the step of the cycle. The procedures provide different functions or criteria for the ergonomic evaluation or for the formal validation.

The specificity of the MultiCom methodology is based on the fact that all the criteria concerning the human factors –sociological and psychological– are taken into account as soon as possible in the design cycle, using a participatory design concept.

4. PARTICIPATORY DESIGN

The processes of participatory design developed themselves from the years 70 in Sweden under the shape of distribution of the power between employers and trade unions. The processes evolved then, in the years 80, to take the shape of "compilation of the knowledge". In the years 90 finally, Granath (Granath, 96) introduced the concept of "collective conception process." Today, the participatory design is a complex process that enrolls multiple actors in the enterprise but that it is necessary to spread again to the socioeconomic measurements of the use, while integrating the sociologists, anthropologists and economists (Caelen, 04). It is also necessary to orchestrate the process more in order to give to each of the actors of the tools that allow him/her to observe and guide his/her/its activity during the process, while accepting the fact that the conception cannot be entirely a precisely planned process (Suchman, 87).

To put new collaborative methods in place, there is first of all, some basic grounds to clarify in order to extract the knowledge and the practices of all the parties involved in the conception process. This knowledge often belongs to the class of the know-how among the engineers, the practices being deduced form a specialization on the field. Then, it is necessary making to work together the heterogeneous and re-configurable teams. To do this, a set of means must be set up: knowledge bases, communication media, formation, working group management tools, etc. The subject of this article is now to describe the model that we propose for an instrumentation of the participatory design on a dedicated platform, preliminary requirements for the development of exploitable services in an industrial environment.

Our contribution is based on a set of past observations of participatory design sessions, done according to classic techniques of observation of the activity (Clarke, 93). These observations were the starting point of our gait. They were based on the experience acquired during previous projects: IST SIRLAN (home automation), RNRT PVE (vocal portal for enterprises) and RNRT Stylocom (communicating pen), etc. From these observations, we proposed an new activity model, specified via the concepts of primitive, moment and phase.

This model allowed us then to capitalize the knowledge acquired on the design process. To ease this modeling activity, we also developed the tools needed to the instrumentation of the participatory design sessions, to the capitalization of the knowledge on the process, and to the reflexive analysis of the practice. This necessity to rationalize the process of design has been put notably in light by recent work (Darses, 01).

The article is divided into four parts: in a first part we recall the model of the process of participatory design that we proposed and let us clarify how we capitalized it thanks to a dedicated tool. In a second part, we describe the instrumentation of a session of participatory design according to the moment concept (Caelen et al., 04). In a third part, we show in what extends a management tool of traces enables us to analyze in a reflexive manner our practice, and so to have a experience feedback on it. Finally we conclude the article on the importance of the models and tools in the process of participatory design in an industrial context.

4.1. Observation of participatory design sessions

We began to systematize a survey of the processes used in participatory design sessions for small groups. To do so, we defined a grid of observation, divided into five points:

- Activities performed by the actors during the collective sessions,
- Uses of the instruments and tools available in sessions,
- Dialogue acts between actors,
- Roles played by the different actors, unawarenessly or not,
- Knowledge used to perform tasks during sessions.

We refined this grid on some sessions of participatory design around a "communicating pen": sessions of creativeness, sessions of ergonomic conception on scripts, etc.

4.1.1. Primitives

The first analyses show that a work session can be divided into *primitives* as: “to inform the participants”, “to consult them”, “to determine the functions around of which the discussion will take place”, “to make the synthesis of all subjects collected”, etc. The various sessions studied have a variable structure but remain based on the same set of primitives that can be reused in a similar manner in other sessions of the design process. These primitives can be used one or several times during the design process, and are considered as indivisible elements of activity.

4.1.2. Moments

Sets of actors' activities –primitives– linked temporally can be identified in the workflow of the design tasks. At the end of these temporally linked activities, the participants had achieved a tangible act of creation relevant to the design goal (edition of a report or creation of a mock-up for instance). We name these sets of activities moments of the design. A moment can be performed in one or more sessions of the design process. "The assessment on focus-group" is, for example, one moment that can be performed in several sessions. In other words, the moment of the design is seen as a temporally linked set of primitives whose outcome leads to a tangible progress in the design task.

4.1.3. Phases

From a global point of view, the activity of design is a collaborative activity achieved during relatively organized sessions and individual activities lead outside of these sessions. This activity of design belongs by nature to the *situated action* type. However, milestones and phases, that can be decomposed in moments, can be identified. These phases differentiate from each over by a significant change in the nature of the activity (from design to implementation for instance). The most generic design process can therefore be represented by a direct graph (not necessarily acyclic) which nodes represent the moments and which connections represent the possible transitions between moments (fig. 1). The effective sequence of moments is negotiated in an opportunist manner by the actors and is materializes by the addition of a plain transition in the graph.

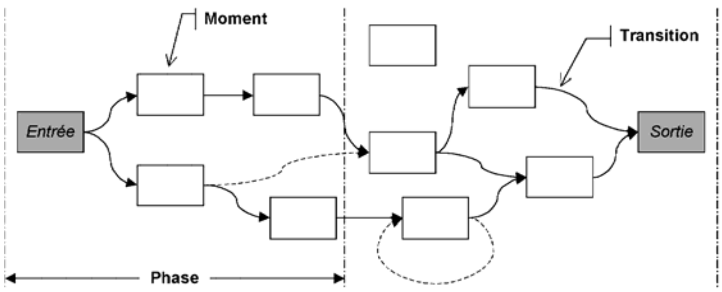

Figure 1: Example of a design process: the first moment in the process is indicated Entry (Entrée), and the last Exit (Sortie). The time progresses from right to left. The transitions in dotted lines are still to be negotiated in the present state of the process, that remains therefore at all times *dynamic*.

4.2. The model

4.2.1. Conceptual model

From the definitions of the phases, moments and primitives deduced from the observations, we formalized these concepts in order to capitalize them in a data base. This formalization has been achieved with the syntax of a diagram of UML classes. The model has been validated with the help of the set of examples of phases, moments and primitives specified casually by the experts of the different disciplines. This formalization had two main interests: (1) to put in light the under-specified points of the model and (2) to determine first specifications for the tool devoted to capitalize them.

However, it quickly appeared that this model was complex to implement as a relational database and that it was more important to present to the user the concepts in a graphical environment rather than to formally verify the constraints of the model. Besides, it seemed us quasi-certain that these constraints are going to be amended in the near future as a consequence of the experience acquired with new projects. Moreover, the management of the links to resources associated with the projects (e.g. files, multimedia data, programs, web sites, etc.), as well as the tools for data extraction (e.g. Gantt diagrams) have a predominant role in the tool usage.

This is why our choice was to reuse a visual tool with hypertext capabilities to assist the scheduling of the projects activities, rather than the creation of a relational database. We chose a commercial software (MindManager®) that we adapted to our needs thanks to the embedded programming language of the tool.

4.2.2. MindManager®

MindManager® (Mindjet, 05) is a commercial software allowing users to perform *Mind Mapping*, that means the representation of their knowledge as concepts and networks. Every concept, represented by a node, can be linked by hypertext to another concept or to another type of element (document, program, Internet link, multimedia resource, etc.). The software embeds, for the majority of usual documents types, of a publisher (or at least a reader) integrated as a plug-in allowing the user to modify (or merely to read) the document with the software, giving him/her the feeling to use a completely integrated knowledge edition environment. MindManager® also features the concept of reusable *map leaves* –i.e. pieces of cards– simulating the mechanism of instantiation. Indeed, pieces of cards can be created by users and stored in a library. They are then reusable as wishes to create new cards. Moreover, some links carry out a semantic (e.g. succession of tasks) and so permit the extraction of specific diagrams for the project management (i.e. Gantt Diagrams).

With our specific parameterization of MindManager®, we represented the capitalized moments as pieces of cards created by the expert practitioners and reusable by any user for new projects. The pieces of cards representing the moments are created by the domain experts (ergonomists, sociologists, project managers, etc.) with the help of a facilitator. The object of the moment, its entries, its exits, its actors are filled-in by the practitioners in a piece of card representing the moment, together with optional specific resources of the moment (printed guide to apply the methodology, tool for support of the participatory design sessions, driver of meeting, model of document, etc.).

These pieces of card are then placed at the disposal of the users in the library. The new projects, created by the users from the moments in library are themselves recorded in a specific history card. During the project, the instantiated moments are used to steer the activity and also as a source of knowledge or models. Once finished, the project instantiated moments and all its resources and productions (reports, movies, models, etc.) are capitalized, and so, reusable for other projects.

4.2.3. Knowledge capitalization

In practice, the general structure of data and knowledge are organized from a root that permits to reach the global database, structured in four parts:

1. Moments: database of the moments (describes the know-how),
2. Projects: database of the projects already executed or under execution,
3. Human resources: database of people and their roles in the projects,
4. Industrial relations: wallet of addresses and contacts.

The projects under execution are managed through a representation in Gantt. Those that are finished are capitalized while distinguishing the knowledge of return-of-experience type from the factual knowledge (e.g. presentations, reports, decisions, etc.).

A project achieved, for example the RNRT Stylocom (communicating pen), is archived in separated categories, the SP –sub-projects–, the reports, the contract document, the presentation form (a poster in this case). Every SP is divided into moments, with for Stylocom in the SP1 (fig. 2): "Analysis of the market competition", "Development of concept", "Creativeness", "Participatory design" (that can be performed in more than one session), "Result of design" and "Investigation of use". In the moment "Creativeness" for example, the sessions of preparation and work are joined to the general diagram of "Creativeness" and linked with the facts and events that took place in the Stylocom project.

The moments embody independent general procedural knowledge of the particular projects themselves. They include the shared data and private data of some actors, as memos, personal notes, know-how, etc. The shared data are in conformity with the formal descriptions given in the previous part completed by specific data as cards of help to make some exercises, tools, models of reports or contracts, etc. The fig. 3 shows an example of moment named "Brainstorming of ideas".

The moment "Creativeness" (*Créativité*) in Stylocom is now joined to the sequence "Preparation session" (*Préparation session*) and "Brainstorming of ideas" (*Séances*) and the fig. 2 shows that this sequence has been repeated two times (1&2).

Finally the access to the set of moments is done via the moment database (fig. 4). In this databas, the moments are grouped in phases. The project manager picks the moments he/her need form the database. He/she links them in a Gantt diagram and validates them with the project team at the end of every moment. He/she can also monitor in real time the evolution of the project and knowledge creation (data, facts, events, decisions, etc.). He/she can also consult the human resources database that contains the set of human resources affected to the projects.

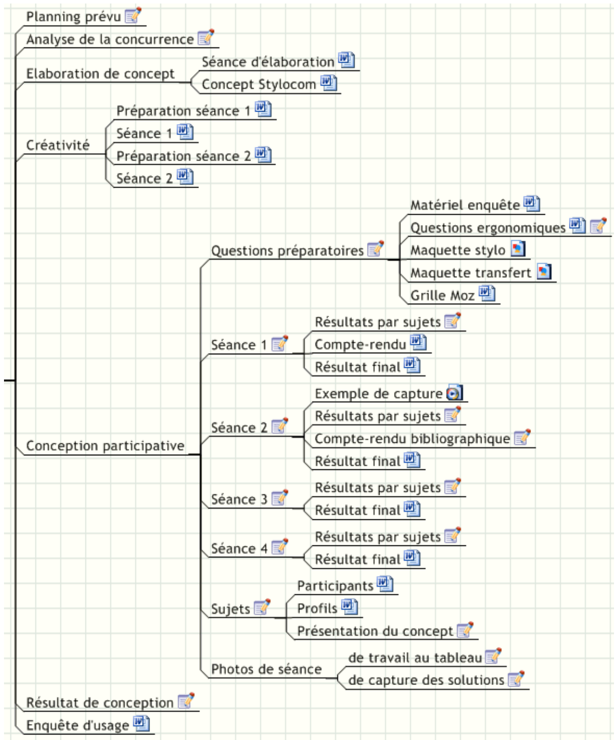

Figure 2: Excerpt (from the sub-project SP1) of the description of an achieved project in the MindManager® tool (RNRT Stylocom project).

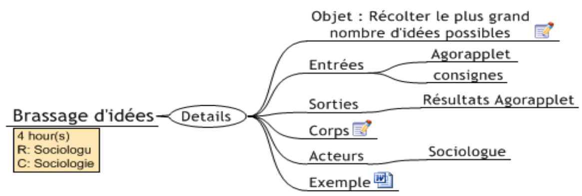

Figure 3: Description of the "Brainstorming of ideas" moment in the MindManager® tool.

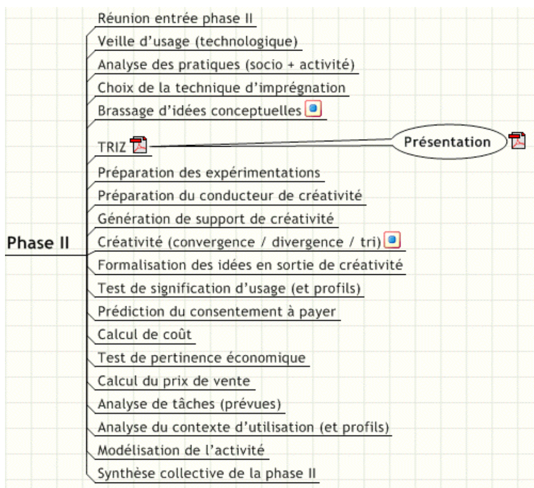

Figure 4: Excerpt (Phase II) of the description of the moment database in the MindManager® tool.

4.3. Example of a moment execution in a smart-room

The organized moment consisted in a creativeness session of type "Brainstorming of ideas". The objective of the session was to find a name to a technological innovation conceived by CEA-Leti. The session took place in the smart-room and lasted about 2h30 (fig. 3). The group was constituted of 6 participants: 3 men and 3 women. Half among them worked in the humanities domain and the other half in the technical domain. Two coordinators drove the session, both sociologists. In addition, a coordinator was in charge of the technical management of the smart-room during the session. A dozen of exercises have been achieved in this session. For the execution of this moment, we chose a "lightweight" instrumentation of the smart-room because it had must be moved out of our laboratory. A wide-angle video camera (left-up corner on figure 5) recorded the video of the session and two cordless mikes (center on figure 5) recorded the comments of the animators and the participants. These two streams were digitalized and store on a computer.

Figure 5: View on a participatory design session.

During this moment, the participants and the animators used an collaborative application specifically developed for this moment: the AGORASuite. This application features a common working space gathering every participant's ideas and animators orders. It so replaces the classic paper-board and enables participants to express their ideas independently, preventing lots during the former classic transcription on the paper-board. Moreover, the AGORASuite enables the animators to automatically reuse ideas expressed in an exercise in the following one, with no delay. The AGORASuite also features an automatic data collection system in order to analyze the activity of the participants. This special feature enables researchers to analyze in a reflexive manner the time-line of the moment performance.

CONCLUSION

In this paper we presented, briefly, our contribution to the instrumentation of participatory design sessions. This contribution has three aspects:

1) We set up an environment for knowledge management dedicated to participatory design. This environment allows us to capitalize and so to reuse the experience acquired form former projects to define new ones.

2) We developed a series of help tools for the execution of the "Brainstorming of ideas" moment. These tools are a meaningful help to the execution of moments, notably for the project management, but also in the project performance, as an help for the practitioners.

3) We created an automated data collection system enabling a reflexive analysis of the activity of the participants. This reflexive analysis will consequently improve the appropriateness of the moments in the library, and so consequently, improving the whole development process.

One of the major advantages of having a usability laboratory as MultiCom, is that the incremental hurdle for user testing of a new product becomes fairly small since all the equipment is already in place in a dedicated room that is available for testing. This effect is important because of the reduced development schedules that often leave little time for delay. Thus, if usability testing can be done now and with minimal overhead, it will get done! Similarly, usability may get left out of a project if there is too much delay or effort involved before results become available. Because of this phenomenon, the support staff form a very important part of a usability laboratory in terms of keeping it up and running, stocked with supplies, and taking care of the practical details of recruiting and scheduling test users.

MultiCom is a consulting and research platform specialized in human factors, usability and safety in product and system design. The following is a listing of service areas provided:

> *User Research:* User research is conducted to support system design specifications to assure optimal interaction between user and system. User research includes user surveys, job and task analyses, human factors profiling of user populations, function allocation and other analyses.
>
> *User Interface Design:* User interface design includes the design of input devices as well the design of screen layout and control elements. Design services include the functional specification of the user interface as well as control and screen layouts.
>
> *Usability Inspections:* Usability inspections are conducted on a user interface to assure compliance of the interface with existing design guidelines, standards and practices. Inspections can be conducted throughout the development process from initial specification to working prototype.
>
> *Usability Testing:* Usability testing is conducted on the product or system with representative end-users engaged in representative tasks. Testing is conducted in the laboratory or the work setting of the end-user.
>
> *Safety Reviews and Inspections:* Safety reviews and inspections of products and systems are conducted by certified human factors and ergonomics professionals in accordance with national and international standards and practices.
>
> *Seminars in User-Centered Design and Evaluation:* Seminars in the user-centered design process and evaluation methods as well fundamentals of human factors in product design are provided to assist clients in improving product usability and safety.
>
> *Human Factors Research:* Ongoing human factors research is conducted to determine the nature and extent of the interactive effects of interface design, user, and task characteristics on overall system performance. The research is both externally and internally funded.

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